HILL
MEMORIAL LIBRARY
LOUISIANA
STATE UNIVERSITY
and
AGRICULTURAL & MECHANICAL
COLLEGE

GIFT

NEW METHOD
BOOK BINDERY INC.
JACKSONVILLE, ILLINOIS

Digitized by the Internet Archive
in 2015

https://archive.org/details/louisianabulleti1141loui

Louisiana Bulletin No. 114. September, 1908.

AGRICULTURAL EXPERIMENT STATION

OF THE

Louisiana State University
and A. and M. College,

BATON ROUGE.

ANALYSES

OF

COMMERCIAL FEEDING STUFFS

J. E. HALLIGAN, B. S.

Baton Rouge, La:
Daily State-Times Print.
1908.

AGRIC. ECON. LIBRARY
LOUISIANA STATE UNIVERSITY

Louisiana State University and A. & M. College

LOUISIANA STATE BOARD OF AGRICULTURE AND IMMIGRATION

EX-OFFICIO.

GOVERNOR JARED Y. SANDERS, *President.*
HENRY L. FUQUA, *Vice President of Board of Supervisors.*
CHAS. SCHULER, *Commissioner of Agriculture and Immigration.*
THOMAS D. BOYD, *President State University.*
W. R. DODSON, *Director Experiment Stations.*

MEMBERS.

R. S. Moore, St. Bernard.
Henry Gerac, Lafayette.
John T. Cole, Monroe.
John J. Henderson, Lagan.
J. E. Bullard, Belmont.
R. E. Thompson, Wilson.
Jeff D. Marks, Crowley.

STATION STAFF.

W. R. DODSON, A.B., B.S., Director, Baton Rouge.
R. E. BLOUIN, M.S., Assistant Director, Audubon Park, New Orleans.
J. G. LEE, B.S., Assistant Director, Calhoun.
S. E. McCLENDON, B.S., Assistant Director, Baton Rouge.
H. P. AGEE, B.S., Chemist and Sugar Maker, Audubon Park, New Orleans.
W. P. NAQUIN, B. S., Assistant Chemist, Audubon Park, New Orleans.
A. B. JOFFRION, B.S., Assistant Chemist, Audubon Park, New Orleans.
P. H. DOHERTY, B.S., Assistant Chemist, Audubon Park, New Orleans.
B. F. HOCHENEDEL, B.S., Assistant Chemist, Audubon Park, New Orleans.
R. E. GRAHAM, B.S., Assistant Chemist, Audubon Park, New Orleans.
WM. G. OWEN, B.S., Bacteriologist, Audubon Park, New Orleans.
J. K. McHUGH, Secretary and Stenographer, Audubon Park, New Orleans.
A. SCHEER, Farm Manager, Audubon Park, New Orleans.
G. D. HARRIS, M.S., M.A., Geologist, Baton Rouge.
F. L. WHITNEY, Assistant Geologist, Baton Rouge.
J. E. HALLIGAN, B.S., Chemist, Baton Rouge.
W. G. TAGGART, B.S., Assistant Chemist, Baton Rouge.
H. L. GREEN, B.S., Assistant Chemist, Baton Rouge.
A. P. KERR, B.S., Assistant Chemist, Baton Rouge.
J. C. SUMMERS, B.S., Assistant Chemist, Baton Rouge.
R. BAUS, B.S., Assistant Chemist, Baton Rouge.
R. G. FULLER, B.S., Assistant Chemist, Baton Rouge.
ROGER P. SWIRE, Treasurer, Baton Rouge.
L. O. REID, Farm Manager, Baton Rouge.
WILMON NEWELL, M.S., Entomologist, Baton Rouge.
J. B. GARRETT, B.S., Associate Entomologist, Baton Rouge.
F. H. BURNETTE, Horticulturist, Baton Rouge.
W. H. DALRYMPLE, M.R.C.V.S., Veterinarian, Baton Rouge.
C. W. EDGERTON, Ph.D., Plant Pathologist, Baton Rouge.
J. T. TANNER, B.A., Secretary and Stenographer, Baton Rouge.
IVY WATSON, Farm Manager, Calhoun.
E. J. WATSON, Horticulturist, Calhoun.
C. E. SELLERS, in charge of Rice Experiments, Crowley.
J. G. LEE, Jr., B.S., in charge of Feeding Experiments, Hammond.
G. L. TIEBOUT, B.S., Assistant Horticulturist, Roseland.

LA. STATE UNIV. LIBRARY

7-18-05
[illegible]
Gift
La. Coll. - Agric.

12412
14

COMMERCIAL FEEDING STUFFS.

J. E. HALLIGAN.*

During the past season the following analyses of feed stuffs have been made at this Station:

Cotton seed meals	800
Cotton seed feeds	23
Rice brans	312
Rice polishes	151
Wheat brans	1,294
Wheat middlings (shorts)	226
Wheat mixed feeds (bran and middlings)	30
Wheat feeds with admixtures	155
Molasses feeds	861
Corn chops	3,134
Corn and oat feeds	640
Feed mixtures	357
Hominy feeds	55
Feed meals	68
Brewers' grains	87
Poultry feeds	357
Miscellaneous	65
Total analyses	8,615

Copies of the Feed Stuff Law can be secured by applying to the Commissioner of Agriculture.

COTTON SEED MEAL.

COMMERCIAL CLASSIFICATION.

The Inter-State Cotton Seed Crushers' Association, at its meeting in Louisville, Ky., May 19-21, 1908, adopted the following as a standard classification for cotton seed meal.

---

*With the assistance of H. L. Green, B. S.; J. C. Summers, B. S.; A. B. Joffrion, B. S., and R. G. Fuller, B. S.

S. W. Pipes, B. S., and W. D. Morgan, B. S., assisted in reporting some of the results.

298042

"*Choice cotton seed meal* must be finely ground, perfectly sound and sweet in odor, yellow, free from excess of lint, and by analysis must contain 8 per cent of ammonia, or 49 per cent of combined protein and fat."

"*Prime cotton seed meal* must be finely ground, of sweet odor, reasonably bright in color, yellow, not brown or reddish, free from lint, and by analysis must contain at least 7 1-2 per cent of ammonia, or 46 per cent of combined protein and fat."

"*Good cotton seed meal* must be finely ground, of sweet odor, reasonably bright in color, and by analysis must contain at least 7 per cent of ammonia, or 43 per cent of combined protein and fat."

CLASSIFICATION USED IN THIS BULLETIN.

The meals in the following tables are classified according to the protein equivalents of the ammonia standards mentioned in the above classification. For example:

Choice cotton seed meal calls for 8 per cent ammonia, which is equivalent to 41.15 per cent protein; that is, all meals carrying 41.15 protein or over are called choice.

Prime cotton seed meals are those carrying 7.50 per cent ammonia, which is equivalent to 38.50 per cent protein.

Good cotton seed meal carries 7 per cent ammonia, which is equivalent to 36 per cent protein.

The color, odor and fat contents are not considered in the classification in this bulletin. There are some companies whose goods appear under more than one head.

GENERAL REMARKS.

The seed the past season carried a high protein content, and those meals that were free from an excess of lint and hulls ran high in protein. The cotton seed meals varied from 32.06 per cent to 50.88 per cent of protein and they varied from 3.64 per cent to 17.15 per cent of fat.

The great variation as indicated in the above figures, in the quality of cotton seed meal as manufactured, shows the necessity for demanding a guarantee. For feeding purposes a bright yellow meal free from excess of lint and hulls, and sweet in odor, should be selected.

CLASSIFICATION OF SAMPLES ANALYZED.

CLASS	Number of Samples	Number of Brands	Number equal to or above the Guarantee in Protein, Fat and Carbohydrates	Below the Guarantee in		
				Protein	Fat	Carbohydrates
Choice	614	46	209	54	270	246
Prime	174	27	28	39	71	104
Good	12	3	0	10	6	3
Total	800	76	237	103	347	353

COTTON SEED FEEDS.

Those cotton seed meals falling below 36 per cent protein are classed as cotton seed feeds. These feeds are made up of varying quantities of cotton seed meal, lint and hulls. If such a feed is desired it is perhaps cheaper for the feeder to purchase the meal and hulls separately and mix them himself. Cotton seed feeds are, as a class, more expensive than cotton seed meal, for the amount of protein received.

These feeds varied from 18.88 per cent to 26.06 per cent protein, 3.93 per cent to 9.14 per cent fat and 17.87 per cent to 24.91 per cent fiber.

CLASSIFICATION OF SAMPLES ANALYZED.

Number of Samples	Number of Brands	Number equal to or above the Guarantee in Protein, Fat and Carbohydrates	Below the Guarantee in		
			Protein	Fat	Carbohydrates
23	2	1	12	17	16

RICE BRAN.

Rice bran is made up of the outer layer of the rice kernel, together with some of the germ. The quality of rice bran put out this last season has been better than for any previous year since our feed stuff law has been in effect. There are still some companies putting out a mixture of rice bran and rice hulls, who offer this product to the trade for rice bran.

From correspondence with this office we find that some of the parties do not seem to realize the depreciating effect which an excessive amount of hulls mixed with rice bran has on the product. They are not all putting out such mixtures to defraud, but merely through ignorance. Consequently we wish to draw the attention of such manufacturers and dealers to the necessity of eliminating the hulls.

By perusing the following tables, where the analyses of the rice brans are enumerated, the best brands of this class of feed can be picked out.

The following standard has been adopted by this laboratory for a good rice bran. The protein content should reach 12.50 per cent, fat 10 per cent, fiber not over 10 per cent, and ash not over 9 per cent. The rice bran should smell sweet and be free from rancidity. Allowance is made for the different styles of machinery used in the manufacture of rice bran in setting the above standard.

The per cent of hulls given in this bulletin is figured by the following formula as worked out by Dr. Browne, formerly chemist of the Louisiana Sugar Experiment Station, who made extensive investigations on rice products.

Per cent hulls=3.33x (per cent fiber—10) assuming that the hulls carry 40 per cent fiber and the bran runs 10 per cent fiber.

A sample of rice bran with 30 per cent fiber would be considered as containing 66.60 per cent hulls.

Example: Per cent hulls= 3.33x (30—10).
3.33x20=66.60 per cent.

It must be remembered that many adulterated rice brans reach their guarantee, yet they may be injurious to the digestive organs of the animal to which they are fed, when the per cent of hulls is high.

The protein content of rice bran seemed to be a little higher than in previous years.

Good rice bran is about the cheapest feed stuff found on our market.

The analyses of these feeds show a variation from 4.50 per cent to 15.34 per cent protein, 0.98 per cent to 16.18 per cent fat, 29.09 per cent to 56.42 per cent carbohydrates, 5.75 per cent to 37.87 per cent fiber, and 4.47 per cent to 18.54 per cent ash.

CLASSIFICATION OF SAMPLES ANALYZED.

Number of Samples	Number of Brands	Number equal to or above the Guarantee in Protein, Fat and Carbohydrates	Below the Guarantee in		
			Protein	Fat	Carbohydrates
312	41	85	5	96	49

RICE POLISH

Rice polish consists of the flour which is removed from the rice kernel in giving it the pearly lustre that the trade demands.

Some samples contained grits and hulls. By rubbing a small portion between the fingers the grits can be detected.

The protein in these feeds varied from 10.25 per cent to 14.50 per cent, the fat from 3.94 per cent to 11.68 per cent, the carbohydrates from 54.51 per cent to 72.57 per cent, and the fiber from 0.74 per cent to 4.88 per cent.

Some of the guarantees on these feeds are not always an indication of the composition.

CLASSIFICATION OF SAMPLES ANALYZED.

Number of Samples	Number of Brands	Number equal to or above the Guarantee in Protein, Fat and Carbohydrates	Below the Guarantee in		
			Protein	Fat	Carbohydrates
151	36	17	7	35	37

WHEAT BRAN.

Wheat bran consists mostly of the outer portions of the wheat kernel. There was a considerable quantity of this feed consumed in this State the past season. A few samples contained oat hulls, light oats, screenings and weed seeds. Most of the shipments were of good quality. Wheat bran should carry 15 per cent protein to be of standard quality.

The shipments for the past season ranged from 12.13 per cent to 19.49 per cent protein, 2.75 per cent to 5.35 per cent fat, 5.55 per cent to 13.75 per cent fiber.

CLASSIFICATION OF SAMPLES ANALYZED.

Number of Samples	Number of Brands	Number equal to or above the Guarantee in Protein, Fat and Carbohydrates	Below the Guarantee in		
			Protein	Fat	Carbohydrates
1294	85	365	34	181	465

WHEAT MIDDLINGS (SHORTS).

Wheat middlings, sometimes called shorts, consists principally of the inner layers of the outer covering of the wheat kernel.

The samples examined ran from 14 per cent to 21.75 per cent protein and 1.37 per cent to 7.05 per cent fat.

This class of feed should contain 17 per cent protein.

CLASSIFICATION OF SAMPLES ANALYZED.

Number of Samples	Number of Brands	Number equal to or above the Guarantee in Protein, Fat and Carbohydrates	Below the Guarantee in		
			Protein	Fat	Carbohydrates
226	39	99	4	29	48

WHEAT MIXED FEED.

Wheat mixed feed is a mixture of wheat bran and middlings in varying proportions and it should contain 16 per cent protein.

There was very little of this feed sold in this State.

CLASSIFICATION OF SAMPLES ANALYZED.

Number of Samples	Number of Brands	Number equal to or above the Guarantee in Protein, Fat and Carbohydrates	Below the Guarantee in		
			Protein	Fat	Carbohydrates
30	2	6	0	3	24

WHEAT FEEDS WITH ADMIXTURES.

These feeds are made up of wheat products, corn, ground corn cobs, corn bran, oat hulls, etc.

In purchasing this class of feed the consumer generally pays as much as for the genuine wheat products. Most of these feeds are so finely ground that it is almost impossible to detect the adulteration with the naked eye.

The trade in this class of feed seems to be increasing and there is no doubt but that many of these feeds are sold as pure wheat products. Wheat feeds should be avoided that are guaranteed less than 15 per cent protein.

This class of feed varied from 7.50 per cent to 18.35 per cent protein, 1.86 per çent to 5.49 per cent fat, and 3.79 per cent to 23.72 per cent fiber.

CLASSIFICATION OF SAMPLES ANALYZED.

Number of Samples	Number of Brands	Number equal to or above the Guarantee in Protein, Fat and Carbohydrates	Below the Guarantee in		
			Protein	Fat	Carbohydrates
155	16	23	5	2	26

MOLASSES FEEDS.

There has been some trouble experienced with molasses feeds this past season, due to decomposition. Some of the samples contained lumps of molasses, showing that they were not well mixed.

Unground weed seeds were found in some shipments. These are objectionable, as they sometimes pass through the animal undigested, and so they are a source of disseminating weeds. From the correspondence we have had with some of the manufacturers of this class of feed we find that they are endeavoring to give our feeders a good product. It is not their intention to defraud. Two brands of these feeds were improved during the year by using better primary products.

Care should be exercised in keeping down the moisture content, as an excess of moisture tends to promote decomposition. The purchaser should avoid shipments that are not in good mechanical condition and feeds that smell rancid and contain over 12 per cent of moisture.

Thse feeds varied from 9.13 per cent to 18.44 per cent protein, 0.94 per cent to 9.14 per cent fat, 5.50 per cent to 16.73 per cent fiber, and 8.23 per cent to 18.75 per cent water.

CLASSIFICATION OF SAMPLES ANALYZED.

Number of Samples	Number of Brands	Number equal to or above the Guarantee in Protein, Fat and Carbohydrates	Below the Guarantee in		
			Protein	Fat	Carbohydrates
861	6	124	162	54	295

CORN CHOPS.

Corn chops, as sold in this State, is the cracked grain of corn. Many of the shipments of this feed were made up of inferior corn and some of the samples contained corn cobs. When corn chops are moldy or fermented a chemical analysis does not always reveal this condition, and in such cases a chemical analysis does not serve as a criterion of the actual value of this product.

To be of good standard quality this feed should contain 9 per cent protein, should be free from fermentation and adulteration; should smell sweet and look clean, and be made from sound grains of corn.

A close physical examinatoin will reveal the quality of this material to a great extent.

The analyses for the season vary from 7.13 per cent to 11.56 per cent protein, 2.19 per cent to 6.12 per cent fat, and 66.58 per cent to 75.46 per cent carbohydrates.

Some of the guarantees on corn chops bear no relation to the composition of this product.

CLASSIFICATION OF SAMPLES ANALYZED.

Number of Samples	Number of Brands	Number equal to or above the Guarantee in Protein, Fat and Carbohydrates	Below the Guarantee in		
			Protein	Fat	Carbohydrates
3134	65	865	831	1664	841

CORN AND OAT FEEDS.

These feeds are made up of mixtures of factory products or waste products with corn and oats. Many of these feeds contain oat hulls and most of the shipments showed the presence of salt.

These feeds showed a variation of 7.44 per cent to 10 per cent protein, 2.62 per cent to 5.50 per cent fat, 5.57 per cent to 16.58 per cent fiber.

CLASSIFICATION OF SAMPLES ANALYZED.

Number of Samples	Number of Brands	Number equal to or above the Guarantee in Protein, Fat and Carbohydrates	Below the Guarantee in		
			Protein	Fat	Carbohydrates
640	7	199	6	402	14

FEED MIXTURES.

Under this head come those feeds which are made up of mixtures of alfalfa, brewers' grains, corn products, oat products, gluten feed, wheat products, rice products, barley, cotton seed meal, etc.

The results of the analyses show that these feeds vary from 8.75 per cent to 21.75 per cent protein, 2.36 per cent to 7.72 per cent fat, and 2.87 per cent to 21.52 per cent fiber.

CLASSIFICATION OF SAMPLES ANALYZED.

Number of Samples	Number of Brands	Number equal to or above the Guarantee in Protein, Fat and Carbohydrates	Below the Guarantee in		
			Protein	Fat	Carbohydrates
357	22	30	41	41	81

HOMINY FEED AND FEED MEAL.

Hominy feed and feed meal consists of the softer parts of corn kernel, which is the remaining product from the manufacture of hominy or hominy grits and starch, etc.

The feed meals as a class run lower in protein and fat than the hominy feeds.

The analyses for this season show a variation in protein from 7.37 per cent to 13.38 per cent, in fat from 2.43 per cent to 9.50 per cent, in carbohydrates from 60.97 per cent to 73.04 per cent, and in fiber from 1.35 per cent to 11.76 per cent.

CLASSIFICATION OF SAMPLES ANALYZED.

Number of Samples	Number of Brands	Number equal to or above the Guarantee in Protein, Fat and Carbohydrates	Below the Guarantee in		
			Protein	Fat	Carbohydrates
123	10	9	1	14	16

BREWERS' GRAINS.

Dried brewers' grains are the kiln-dried by-product from the manufacture of beer and they consist principally of barley grains from which the starch and other soluble matter has been extracted.

This by-product is used to quite an extent in fortifying mixed feeds to raise the protein content. Samples of the same brand of this material often give a variation in the results. Most of the samples received this year have been up to the standard. This feed should contain 22 per cent protein, 5 per cent fat and not over 16 per cent fiber.

The samples analyzed this year run from 20.94 per cent to 30.56 per cent protein, from 5.59 per cent to 7.67 per cent fat, from 35.25 per cent to 44.71 per cent carbohydrates and from 11.20 per cent to 17.72 per cent fiber.

CLASSIFICATION OF SAMPLES ANALYZED.

Number of Samples	Number of Brands	Number equal to or above the Guarantee in Protein, Fat and Carbohydrates	Below the Guarantee in		
			Protein	Fat	Carbohydrates
87	4	49	22	0	13

POULTRY FEEDS.

Poultry feeds are composed of mixtures of corn (whole or cracked), wheat, wheat by-products, oats, oat refuse, cotton seed meal, linseed meal, ground alfalfa, clover, peas, millet seeds, rye, sunflower seeds, barley, weed seeds, animal by-products, sweepings, shells, grit, charcoal and other waste products.

These feeds should be purchased on the protein content, as this nutrient is generally what poultry require. Eggs are made up largely of protein and the common food given to poultry is generally lacking in this constituent. Shells, grit and charcoal are present in some of these feeds and as a general rule these materials can be purchased cheaper by themselves than in a poultry food. The per cent of ash is an indication of the shell and grit content and these feeds should not carry over 6 per cent ash. Unground weed seeds were found in some of these feeds. Such material should not be used in these mixtures, as they are a means of scattering weeds all over the country. There were some samples which contained sweepings and although these shipments reached their guarantees in many cases, the consumer should demand a cleaner article.

A close physical examination will reveal a great deal as to the character of these feeds. Avoid feeds which contain sweepings, grit and excess of shells, and purchase only those feeds which smell sweet and show a good clean appearance.

The poultry feeds varied from 8.44 per cent to 16.63 per cent protein, 2 per cent to 7.20 per cent fat, and 1.34 per cent to 22.73 per cent ash.

CLASSIFICATION OF SAMPLES ANALYZED.

Number of Samples	Number of Brands	Number equal to or above the Guarantee in Protein, Fat and Carbohydrates	Below the Guarantee in		
			Protein	Fat	Carbohydrates
346	25	75	84	216	47

BEEF SCRAPS.

The beef scraps received this year were of good quality, although some of the shipments failed to meet their guarantee. In purchasing this material avoid those shipments that are very much tainted.

The samples examined analyzed from 54.19 per cent to 61.25 per cent protein, and 11.32 per cent to 15.49 per cent fat.

CLASSIFICATION OF SAMPLES ANALYZED.

Number of Samples	Number of Brands	Number equal to or above the Guarantee in Protein and Fat	Below the Guarantee in	
			Protein	Fat
9	2	5	4	0

BLOOD MEAL.

Two shipments of blood meal were analyzed and both samples were below the guarantee. These shipments were in good condition.

SUMMARY FOR THREE YEARS.

The following table shows a comparison of the work done at this laboratory for the past three years:

	1905-6	1906-7	1907-8
Cotton seed meals	588	749	823
Rice brans	177	343	312
Rice polishes	...	142	151
Wheat products	74	1,402	1,705
Molasses feeds	330	442	861
Corn chops	...	2,101	3,134
Corn and oat feeds	543	384	640
Feed mixtures	...	365	357
Hominy feeds	...	42	55
Feed meals	...	65	68
Brewers' grains	29	46	87
Poultry feeds	4	323	357
Miscellaneous	70	65	65
Total analyses	1,815	6,469	8,615

The amendment to the Feed Stuff Law requiring manufacturers to guarantee and tag all ground products not the primary products of grain is the cause of the increase of the many samples in the above table, for the past two seasons, under the headings, Rice Polishes, Wheat Products, Corn Chops, Hominy Feeds, Feed Meals and Poultry Feeds.

AVERAGE ANALYSES.

The following table gives the Average Analyses of some of the different classes of feed stuffs examined and analyzed at this laboratory during the past season:

Class of Feed	Number of Samples	AVERAGE PER CENT OF									
		Protein		Fat		Carbohydrates		Fiber		Water	Ash
		Found	Guarant'd	Found	Guarant'd	Found	Guarant'd	Found	Guarant'd	Found	Found
Choice cotton seed meal........	614	43.49	40.15	9.04	8.65	24.80	23.87	8.18	8.86	8.03	6.46
Prime cotton seed meal........	174	39.89	38.13	8.81	8.85	26.61	26.39	9.83	9.02	8.27	6.59
Good cotton seed meal..........	12	37.21	34.00	9.01	7.20	27.76	28.33	10.82	13.00	8.58	6.62
Cotton seed feed..............	23	22.60	23.00	5.18	5.00	36.46	35.00	22.04	25.00	9.23	4.49
Rice bran.....................	312	11.91	10.25	10.08	10.43	45.19	43.40	12.62	14.50	10.65	9.55
Rice polish...................	151	11.63	10.61	7.46	7.07	64.22	63.12	1.96	1.78	10.76	3.97
Wheat bran....................	1294	16.25	14.06	4.08	3.80	53.97	53.05	8.77	9.79	10.73	6.20
Wheat middlings (shorts)......	226	17.59	15.46	4.46	4.17	57.42	56.72	5.55	6.69	10.59	4.39
Mixed feed (wheat bran and wheat middlings...........	30	16.66	13.86	3.89	3.64	56.23	59.95	7.19	6.56	10.92	5.11
Wheat feed with admixtures....	155	12.90	13.65	3.80	3.64	55.18	54.91	11.83	10.76	10.52	5.77
Molasses feed.................	861	12.54	12.50	4.04	3.25	53.50	53.78	10.60	11.83	12.57	6.75
Corn chops....................	3134	9.35	9.22	3.86	3.87	71.90	68.60	2.09	3.72	11.41	1.39
Feed mixtures.................	357	12.87	11.66	4.09	4.00	56.19	56.55	12.01	12.21	10.19	4.65
Corn and oat feed.............	640	8.42	7.57	3.79	3.64	64.06	60.06	10.35	12.29	9.75	3.63
Hominy feed...................	55	10.50	9.01	8.18	7.48	64.95	59.88	5.05	5.48	8.57	2.75
Feed meal.....................	68	9.48	10.57	5.13	6.26	67.79	62.76	6.63	7.19	8.70	2.27
Alfalfa meal..................	1	15.37	15.01	1.50	1.50	35.00	40.00	26.63	29.50	12.70	8.80
Brewers grains................	87	26.06	23.52	6.45	5.75	40.85	41.39	14.39	14.51	8.70	3.55
Poultry feed..................	346	10.97	10.30	3.32	3.36	64.51	50.73	3.93	7.06	10.76	6.51
Beef scraps...................	9	56.13	55.33	13.91	10.08	.....	.....	.....	.....	.....	.....
Blood meal....................	2	84.66	87.00	.....	.....	.....	.....	.....	.....	.....	.....

FEED ADULTERANTS.

The following table gives the composition of the principal adulterants used in our feeding stuffs. Sweepings are used to some extent in our feeds, but there is such a variation in the composition of this material that the analysis is not given in the table. As a general rule these adulterants are mixed with feeds which command high prices and the addition of such materials generally lowers the value of the feed to which they are added.

By consulting the standards for the several feeds and the analyses as given in this bulletin, the purchaser can easily select the best feeds for his use. Our law, with its thorough control, affords the purchaser every protection. The Louisiana market offers good standard feeds and it is the purchaser's own fault if he allows a spurious article to be sold to him.

COMPOSITION OF FEED ADULTERANTS.

Class	Protein	Fat	Carbohydrates	Fiber	Water	Ash
Ground corn cobs.....	2.40	0.50	54.90	30.10	10.70	1.40
Corn bran............	9.00	5.80	62.20	12.70	9.00	1.30
Oat hulls............	3.30	1.00	52.10	29.70	7.30	6.70
Wheat screenings.....	12.50	3.00	65.10	4.90	11.60	2.90
Cotton seed hulls.....	6.10	2.06	32.91	45.10	11.06	2.77
Rice hulls............	3.50	0.49	26.86	41.89	8.97	18.29

WEIGHT AND MEASURE OF FEED STUFFS.

The following table may be found useful in compounding rations:

	One Quart weighs	One Pound measures
Cotton seed meal*	1.5 lbs.	0.7 qts.
Brewers' grains (dried)*	0.6 "	1.7 "
Wheat middlings (flour)*	1.2 "	0.8 "
Wheat middlings (standard)*	0.8 "	1.3 "
Wheat mixed feed*	0.6 "	1.7 "
Wheat bran*	0.5 "	2.0 "
Whole oats*	1.0 "	1.0 "
Ground oats*	0.7 "	1.4 "
Whole corn*	1.7 "	0.6 "
Corn meal*	1.5 "	0.7 "
Corn and cob meal*	1.4 "	0.7 "
Corn bran*	0.5 "	2.0 "
Hominy meal*	1.1 "	0.9 "
Corn and oat feed (Victor)*	0.7 "	1.4 "
Rice bran	0.8 "	1.3 "
Rice polish	1.2 "	0.8 "
Cotton seed hulls	0.26 "	3.8 "
Alfalfa meal	1.0 "	1.0 "
Molasses (blackstrap)	3.0 "	0.3 "

REBATES.

This laboratory is called upon to figure rebates on a great many shipments of commercial feed stuffs. In order to familiarize the general trade with our system, the following example is given to illustrate the method employed.

The nutrients considered are the protein, fat and carbohydrates. To secure a basis of comparison of values, according to composition we take the relative values as determined by the leading investigators, reduce them to common terms and make a direct ratio. On this basis, one pound of protein is considered of the same value as two and one-half pounds of carbohydrates, and one pound of fat is worth as much as two and a quarter pounds of carbohydrates.

Therefore, to secure the total number of units on which the value is based, we multiply the protein content by 2.50 and the fat content by 2.25 and add these products to the carbohydrate content.

---

*Bulletin No 112, Hatch Experiment Station, Amherst, Mass.

EXAMPLE.—Let us suppose a commercial feed is sold for $32 per ton and guaranteed to contain 14 per cent of protein, 4 per cent of fat and 60 per cent of carbohydrates. By analysis, we find 12.30 per cent of protein, 3.80 per cent of fat and 62.00 per cent of carbohydrates.

Then the percentages of protein, fat and carbohydrates as guaranteed, multiplied by their respective unit values will give the unit values guaranteed of each of these nutrients. The addition of these will give us the total unit value guaranteed. In other words, 14 (the per cent of protein guaranteed) multiplied by 2.50 (the unit value for protein) gives us 35.00 (or the unit value of protein guaranteed).

4 (the per cent of fat guaranteed) multiplied by 2.25 (the unit value of fat) gives us 9.00 (or the unit value of fat guaranteed).

60 (the per cent of carbohydrates guaranteed) multiplied by 1.00 (the unit value for carbohydrates) gives us 60.00 (or the unit value of carbohydrates guaranteed).

That is

14 x 2.50 = 35.00
4 x 2.25 = 9.00
60 x 1.00 = 60.00

Total unit value guaranteed = 104.00

In a similar manner we arrive at the total units found.

EXAMPLE:

12.30 x 2.50 = 30.75
3.80 x 2.25 = 8.55
62.00 x 1.00 = 62.00

Total unit value found = 101.30

That is, the purchaser was guaranteed 104 units for $32.00 a ton, but he received only 101.30 units.

Then, 104 (the unit value guaranteed) is to 101.30 (the unit value found) as 32 (the contract price per ton) is to (the actual price to be paid per ton).

In other words.

104 : 101.30 :: 32 : X   104 X = 3241.60

X=$31.17, or the actual price that should be paid per ton.

$32.00—$31.17=$0.83, the rebate per ton.

Some manufacturers complain at the above system of rebating, as they claim that the digestibility of the protein, fat, and carbohydrates should be considered, and they ask for allowance on digestible fiber, as they say their fiber content is derived from materials that show a high fiber digestibility.

On account of the great variation in the composition of commercial feeds as regards the amounts and kinds of primary products employed in the manufacture of the same, it is impractical and impossible to run digestion exepriments to ascertain the relative value of the protein, fat and carbohydrates in every feed stuff found on our marekt. For example, a mixed feed will be inspected that is made up of corn, rice bran, rice polish, cotton seed meal and molasses. In a month from the above inspection, the same company will change the composition of this same brand of feed, so that it consists of corn, wheat bran, alfalfa and molasses, and the guarantee and the name of the brand will remain unchanged. Under such conditions it is impossible to consider anything except the chemical composition. The market fluctuations seem to influence the composition of some of our feeds.

It is not fair for a manufacturer in settling rebates to figure his feed as valuable as some other feed, as oats for example. Oats may be selling for $37.00 per ton and his feed for $32.00 per ton, and yet the per cent of protein, fat and carbohydrates may be about the same in the two feeds. When a feed is sold to contain a given per cent of protein, fat and carbohydrates for a fixed price, the rebate should be figured on this basis and no other feed should be considered in the settlement.

The system of rebating adopted, as explained above, seems to be the only fair way of settling this much mooted question.

UNIT VALUES OF FEEDS.

The following table gives the classification of some of our feeding stuffs arranged according to their total unit values. For information regarding unit values read the article on this subject under Rebates in this bulletin.

Name of Feed	Protein Unit Value	Fat Unit Value	Carbohydrates Unit Value	Total Unit Value
Cotton seed meal, choice........	102.88	20.25	24.80	147.93
Cotton seed meal, prime........	99.73	19.82	26.61	146.16
Cotton seed meal, good........	93.03	20.27	27.76	141.06
Brewers' grains (dried)........	65.15	14.51	40.85	120.51
Wheat middlings (shorts)......	43.98	10.03	57.42	111.43
Rice polish..................	29.08	16.78	64.22	110.08
Hominy meal.................	26.25	18.41	64.95	109.61
Wheat mixed feed............	41.65	8.75	56.23	106.63
Cotton seed feed.............	56.50	11.66	36.46	104.62
Corn chops..................	23.38	8.68	71.77	103.83
Wheat bran..................	40.63	9.18	53.97	103.78
Feed meal...................	23.70	11.54	67.79	103.03
Rice bran (standard).........	31.25	22.50	49.00	102.75
Nutriline	29.92	13.75	58.30	101.97
Sucrene dairy................	42.83	11.45	46.87	101.15
Purina feed..................	32.50	9.29	58.65	100.44
Ralston Purina Co.—Peerless..	31.80	9.68	56.25	97.73
Great Western Excelsior.......	21.53	10.53	64.46	96.52
Oats	27.50	10.00	59.00	96.50
Weiss Alfalfa Stock Food No. 2.	30.08	7.49	58.43	96.00
Great Western Boss...........	21.48	9.99	64.49	95.96
Stafolife	29.95	13.25	51.79	94.99
Quaker Oats Banner Feed.....	22.55	7.27	64.80	94.62
Great Western Durham.......	20.85	9.09	64.61	94.55
Sucrene Horse, Mule and Ox...	29.20	8.33	56.67	94.20
Valley Delta.................	20.77	8.89	63.36	93.02
Victor Corn and Oat Feed.....	20.25	6.89	64.11	91.25
Rice bran (16% hulls)........	24.50	22.28	44.00	90.78
Corno Horse and Mule........	24.28	7.92	58.37	90.57
Alfalfa meal.................	37.50	3.38	34.00	74.88
Molasses (blackstrap).........			65.90	65.90
Cotton seed hulls.............	12.50	4.50	33.00	50.00

UNIT VALUES OF FEEDS—Continued.

POULTRY FEEDS.

Name of Feed	Protein Unit Value	Fat Unit Value	Carbohydrates Unit Value	Total Unit Value
Purina Chick	28.65	8.48	68.24	105.37
Purina Scratch	27.48	7.60	69.41	104.49
Corno Hen	25.62	7.18	71.36	104.16
Corno Chick	26.88	5.87	70.53	103.28
Schumacher Scratching Grains	26.35	6.93	68.94	102.22
Steinmesch Chick	31.70	13.77	55.76	101.23
Valley Acme Chick	25.63	7.29	65.37	98.29
Steinmesch Hen	26.58	7.58	61.00	95.16
Chamberlain Hen	24.38	6.77	61.19	92.34
Chamberlain Chick	28.83	6.14	56.50	91.47

ANALYSES OF MISCELLANEOUS FEEDING MATERIALS EXAMINED AT THIS LABORATORY.

Name of Material	Protein	Fat	Carbohydrates	Fiber	Water	Ash	Water Free Basis				
							Protein	Fat	Carbohy-drates	Fiber	Ash
Lespedeza	13.60	2.38	40.93	27.58	11.37	4.14	15.35	2.68	46.19	31.11	4.67
Lespedeza and grass	7.05	3.07	41.10	31.79	11.74	5.25	7.99	3.48	46.56	36.02	5.95
Lespedeza leaves	12.25	5.60	39.65	22.13	12.37	8.00	13.98	6.39	45.25	25.25	9.13
Bermuda grass, not fully matured, collected as a cow would gather it	3.86	0.98	20.59	10.03	62.00	2.54	10.16	2.58	54.18	26.40	6.68
Carpet grass, not fully matured, collected as a cow would gather it	3.60	1.07	14.04	6.16	72.00	3.13	12.86	3.82	50.14	22.00	11.18
Para grass, cut in August, panicum molle	1.41	0.61	13.38	8.62	73.50	2.48	5.33	2.29	50.49	32.53	9.36
Para grass, cut in October	1.95	0.48	13.46	9.81	72.00	2.30	6.97	1.71	48.07	35.04	8.21
Guinea grass—panicum jumentorum	2.22	0.71	12.09	10.87	71.50	2.61	7.79	2.49	42.42	38.14	9.16
Paspalum dilatatum—large water grass	2.04	0.70	15.20	11.74	66.50	3.82	6.09	2.09	45.37	35.05	11.40
Barnyard grass, paspalum crusgalli	10.00	3.26	47.50	21.15	11.47	6.62	11.30	3.68	53.66	23.89	7.47
Barnyard grass seeds	12.78	5.30	58.97	9.93	9.49	3.53	14.12	5.86	65.15	10.97	3.90
Paspalum vaseyanum	1.90	0.50	14.72	11.64	68.00	3.24	5.94	1.56	46.00	36.38	10.12
Daisy fleabane, erigeron ramosis	7.19	2.90	49.12	25.33	8.35	7.11	7.85	3.16	53.59	27.64	7.76
Bloodweed, ambrosia species	3.72	1.25	13.77	9.05	68.68	3.53	11.88	3.99	43.96	28.90	11.27
Milkweed, common euphorbia of the alluvial cane bottoms	1.73	0.80	13.70	6.18	75.60	1.99	7.09	3.28	56.14	25.33	8.16
Cane tops (leaves), average of 15 analyses	1.70	0.69	2.20	18.80	74.38	2.23	6.64	2.69	8.59	73.38	8.70
Cane stalks, average of 15 analyses	0.58	0.38	13.40	10.04	74.96	0.64	2.32	1.52	53.51	40.10	2.55
Cane roots, average of 15 analyses	1.59	0.54	6.34	20.87	68.79	1.87	5.09	1.73	20.31	66.88	5.99
Sorghum ensilage (top of silo)	2.38	0.69	14.57	9.55	70.03	2.78	7.94	2.30	48.62	31.86	9.28

ANALYSES OF MISCELLANEOUS FEEDING MATERIALS EXAMINED AT THIS LABORATORY—Continued.

Name of Material	Protein	Fat	Carbohydrates	Fiber	Water	Ash	Water Free Basis				
							Protein	Fat	Carbohydrates	Fiber	Ash
Sorghum ensilage (middle of silo)	2.84	1.09	13.16	7.92	68.00	6.99	8.88	3.41	41.12	24.75	21.84
Fresh cane top ensilage	1.53	0.41	15.62	8.87	71.50	2.07	5.37	1.44	54.81	31.12	7.26
Cane top ensilage two weeks old	1.25	0.44	11.83	8.04	76.50	1.94	5.31	1.87	50.35	34.19	8.28
Japanese cane ensilage (top of silo)	1.53	0.56	9.75	8.60	77.58	1.98	6.82	2.50	43.49	38.36	8.83
Crab grass ensilage (some bermuda grass)	2.17	0.91	15.18	9.93	68.68	3.13	6.93	2.91	48.47	31.70	9.99
Dried beet pulp	9.03	1.49	56.98	18.78	10.35	3.37	10.07	1.66	63.56	20.95	3.76
Beet tops, Lane's Improved Sugar Beet	2.65	0.29	5.01	1.15	89.50	1.40	25.24	2.76	47.72	10.95	13.33
Beet tops, Klein Wunzleben	2.33	0.38	4.46	1.02	90.50	1.31	24.53	4.00	46.95	10.73	13.79
Beet tops, Mangle Wurtzel	2.59	0.18	2.83	1.01	91.75	1.64	31.39	2.18	34.30	12.25	19.88
Beet roots, Lane's Improved Sugar Beet*	1.90	0.05	9.59	0.92	86.20	1.34	13.82	0.36	69.47	6.65	9.70
Beet roots, Klein Wunzleben*	1.37	0.02	8.01	0.82	88.40	1.38	11.81	0.17	69.05	7.07	11.90
Beet roots, Mangle Wurtzel*	1.01	0.05	2.51	0.71	94.40	1.32	18.04	0.89	44.82	12.68	23.57
Turnip tops, Purple Top Globe	2.44	0.38	6.56	1.47	86.00	3.15	17.43	2.71	46.86	10.50	22.50
Turnip tops, Yellow Abberdeen	2.91	0.38	8.10	1.60	84.00	3.01	18.19	2.38	50.62	10.00	18.81
Turnip tops, White Flat Dutch	3.02	0.45	6.85	1.35	85.33	3.00	20.59	3.06	46.70	9.20	20.45
Turnip tops, White Egg	2.61	0.43	7.78	1.70	84.33	3.15	16.64	2.77	49.63	10.83	20.13
Turnip tops, Red Top Strap Leaf	3.03	0.55	7.25	1.39	85.33	2.45	20.67	3.76	49.43	9.45	16.69
Turnip roots, Purple Top Globe*	0.91	0.03	5.31	0.96	92.00	0.79	11.47	0.34	66.32	12.00	9.87
Turnip roots, Yellow Abberdeen*	1.21	0.06	5.71	1.02	91.00	1.00	13.47	0.62	63.43	11.41	11.07
Turnip roots, White Flat Dutch	1.25	0.05	6.07	0.96	90.67	1.00	13.44	0.55	65.05	10.27	10.69
Turnip roots, White Egg*	1.00	0.03	6.53	0.94	90.67	0.83	10.73	0.45	71.02	8.95	8.85
Turnip roots, Red Top Strap Leaf	1.76	0.09	8.92	1.54	86.33	1.36	12.93	0.64	65.21	11.27	9.95

ANALYSES OF MISCELLANEOUS FEEDING MATERIALS EXAMINED AT THIS LABORATORY—Continued.

Name of Material	Protein	Fat	Carbohydrates	Fiber	Water	Ash	Water Free Basis				
							Protein	Fat	Carbohy-drates	Fiber	Ash
Carrot roots, Large White Belgian*	1.71	0.17	7.57	1.22	87.92	1.41	14.16	1.41	62.66	10.10	11.67
Carrot roots, Victoria*	1.45	0.16	7.97	1.29	87.86	1.27	11.94	1.32	65.65	10.63	10.46
Sweet potato roots, Southern Queen*	2.07	0.29	19.32	0.60	76.91	0.81	8.96	1.22	83.77	2.56	3.49
Yam roots, Dooley*	2.18	0.28	29.27	0.94	66.22	1.11	6.44	0.84	86.62	2.79	3.31
Cotton seed hulls†	8.28	5.35	35.36	38.64	8.91	3.46	9.09	5.87	38.82	42.42	3.80
Cotton seed meats†	34.54	31.53	18.22	4.24	6.63	4.84	36.99	33.77	19.52	4.54	5.18

†These samples are the products obtained with a farm separating machine.

*Lane's Improved Sugar Beet—95 tons per acre.
Klein Wunzleben—70 tons per acre.
Mangle Wurtzel—73 tons per acre.
Purple Top Globe—16 tons per acre.
Yellow Abberdeen—13 tons per acre.
White Egg—10 tons per acre.
Large White Belgian—19 tons per acre.
Victoria—14.5 tons per acre.
Southern Queen—350 bushels per acre.
Dooley Yam—300 bushels per acre.

CHOICE COTTON

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Abbeville Cotton Oil Co., Abbeville, La.		
Cotton Seed Meal Feed	2281	2
	2937	1
	3178	1
Average		4
Arcadia Cotton Oil and Manufacturing Co., Arcadia, La.		
Cotton Seed Meal Feed	2431	2
	2973	1
	3329	2
	3437	2
	3582	1
	3860	1
	4330	1
	5430	1
Average		11
Arcola Oil Mill, Arcola, Miss.		
Cotton Seed Meal Feed	3335	6
	4105	2
	4992	1
	5040	1
Average		10
Banner Cotton Oil Co., Kentwood, La.		
Cotton Seed Meal Feed	3162	2
	3286	3
	3732	2
	4166	2
Average		9
Cotton Seed Meal Feed	2272	2
	2443	2
	2590	1
	2758	2
	2838	1
Average		8

SEED MEALS.*

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Fo %	Foun %
39.56	43.00	12.48	12.00	21.47	20.00	12.12	7.00	9.39	5.28
45.50	43.00	10.53	12.00	21.39	20.00	8.41	7.00	8.60	5.57
45.50	43.00	9.57	12.00	22.46	20.00	7.50	7.00	9.40	5.57
—	—	—	—	—	—	—	—	—	—
43.52	43.00	10.86	12.00	21.78	20.00	9.34	7.00	9.13	5.37
45.38	42.00	7.11	8.00	26.13	15.00	6.54	10.00	8.55	6.29
46.06	.42.00	8.05	8.00	25.45	15.00	7.23	10.00	6.56	6.65
45.44	42.00	8.24	8.00	25.50	15.00	6.66	10.00	7.43	6.73
44.13	42.00	7.80	8.00	20.76	15.00	12.33	10.00	8.61	6.37
42.75	42.00	8.29	8.00	26.30	15.00	8.43	10.00	7.44	6.79
44.44	42.00	7.22	8.00	26.21	15.00	6.85	10.00	9.07	6.21
43.19	42.00	8.18	8.00	27.41	15.00	6.89	10.00	7.89	6.44
44.50	42.00	9.16	8.00	24.24	15.00	6.31	10.00	9.18	6.61
—	—	—	—	—	—	—	—	—	—
44.49	42.00	8.01	8.00	25.25	15.00	7.65	10.00	8.09	6.51
37.56	41.00	8.88	8.00	27.85	25.00	10.34	8.00	8.26	7.11
41.94	41.00	8.19	8.00	26.64	25.00	7.56	8.00	8.23	7.44
43.35	41.00	9.97	8.00	27.23	25.00	6.34	8.00	5.68	7.43
42.69	41.00	8.11	8.00	28.58	25.00	6.73	8.00	6.39	7.50
—	—	—	—	—	—	—	—	—	—
41.39	41.00	8.79	8.00	27.57	25.00	7.74	8.00	7.14	7.37
44.56	40.00	9.14	7.00	24.59	25.00	7.04	10.00	8.19	6.48
45.13	40.00	8.83	7.00	24.73	25.00	7.30	10.00	7.34	6.67
44.69	40.00	8.86	7.00	24.21	25.00	6.86	10.00	8.54	6.84
45.13	40.00	10.07	7.00	23.98	25.00	6.52	10.00	7.44	6.86
—	—	—	—	—	—	—	—	—	—
44.88	40.00	9.22	7.00	24.38	25.00	6.93	10.00	7.88	6.71
45.38	40.00	10.23	8.00	22.31	25.00	6.06	3.00	9.40	6.62
46.44	40.00	9.53	8.00	23.68	25.00	6.22	3.00	7.34	6.79
44.93	40.00	11.60	8.00	22.62	25.00	5.74	3.00	8.63	6.48
42.55	40.00	11.45	8.00	23.51	25.00	7.89	3.00	8.43	6.17
44.13	40.00	9.86	8.00	23.67	25.00	7.29	3.00	8.86	6.13
—	—	—	—	—	—	—	—	—	—
44.69	40.00	10.53	8.00	23.16	25.00	6.64	3.00	8.53	6.45

---

*The color, odor and fat contents are not considered in grading these meals.

CHOICE COTTON

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Bastrop Cotton Oil Co., Bastrop, La.		
Cotton Seed Meal	2493	1
	2822	1
	3418	2
	4017	1
Average		5
Boyce Cotton Oil and Manufacturing Co., Boyce, La.		
Cotton Seed Meal	2890	1
	3129	1
	3322	1
	4124	1
Average		4
H. E. Bridges, Memphis, Tenn.		
Cotton Seed Meal	2777	1
Broussard Cotton Oil Co., Broussard, La.		
Cotton Seed Meal Feed	2664	1
	3288	1
Average		2
Cinclare Cotton Oil Co., Cinclare, La.		
Cotton Seed Meal Feed	2291	1
	2683	1
	3256	1
	3763	1
	4947	1
Average		5
Clay County Cotton Oil Co., West Point, Miss.		
Cotton Seed Meal Feed	3905	1
	4016	1
	4288	1
	4446	2
	4735	1
Average		6

SEED MEALS.*

PROTEIN		FAT		CARBOHY-DRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
41.19	40.00	7.55	7.50	27.15	15.00	9.37	10.00	8.31	6.43
44.63	40.00	8.86	7.50	23.92	15.00	7.25	10.00	8.50	6.84
40.38	40.00	6.88	7.50	26.87	15.00	11.05	10.00	8.40	6.42
40.50	40.00	9.02	7.50	26.52	15.00	9.50	10.00	7.81	6.65
41.68	40.00	8.08	7.50	26.11	15.00	9.29	10.00	8.26	6.58
38.81	40.00	17.15	8.00	22.91	26.00	7.62	8.00	7.37	6.14
43.38	40.00	10.74	8.00	23.46	26.00	7.65	8.00	7.94	6.83
42.56	40.00	10.59	8.00	23.69	26.00	8.53	8.00	7.90	6.73
41.94	40.00	11.19	8.00	23.43	26.00	7.19	8.00	9.26	6.99
41.67	40.00	12.42	8.00	23.37	26.00	7.75	8.00	8.12	6.67
44.69	41.00	8.27	8.00	26.38	25.00	6.28	8.00	6.82	7.56
39.19	38.86	9.93	7.01	24.43	21.51	13.03	15.96	7.96	5.46
44.00	38.86	8.43	7.01	23.63	21.51	8.99	15.96	8.78	6.17
41.59	38.86	9.19	7.01	24.03	21.51	11.01	15.96	8.37	5.81
41.63	35.00	8.23	6.00	23.51	20.00	9.61	10.00	9.44	7.58
44.13	35.00	8.82	6.00	24.16	20.00	7.53	10.00	8.23	7.13
43.31	35.00	9.11	6.00	24.72	20.00	7.72	10.00	7.35	7.79
42.69	35.00	9.10	6.00	24.74	20.00	8.31	10.00	7.50	7.66
40.25	35.00	7.18	6.00	27.02	20.00	10.01	10.00	8.87	6.67
42.40	35.00	8.49	6.00	24.83	20.00	8.64	10.00	8.28	7.36
42.00	41.00	8.05	8.00	27.89	25.00	8.68	8.00	7.16	6.22
43.00	41.00	8.94	8.00	26.63	25.00	8.41	8.00	6.64	6.38
41.94	41.00	8.38	8.00	27.59	25.00	9.49	8.00	6.49	6.11
43.13	41.00	8.35	8.00	26.39	25.00	7.92	8.00	7.68	6.53
40.50	41.00	9.34	8.00	28.25	25.00	7.83	8.00	7.30	6.78
42.11	41.00	8.61	8.00	27.35	25.00	8.47	8.00	7.05	6.41

*The color, odor and fat contents are not considered in grading these meals.

CHOICE COTTON

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Colfax Cotton Oil Co., Colfax, La.		
Cotton Seed Meal	2870	4
	3128	1
	3471	6
	3707	1
	3862	1
Average		13
De Soto Cotton Oil Co., Mansfield, La.		
Cotton Seed Meal Feed	2536	2
	2716	2
	2814	1
	2974	1
	3569	3
	3619	1
Average		10
Eunice Cotton Oil Co., Eunice, La.		
Cotton Seed Meal Feed	3902	1
J. S. Gordon and Co., Beaumont, Tex.		
Cotton Seed Meal Feed	3622	1
	4647	1
Average		2
Gloster Oil Co., Gloster, Miss.		
Cotton Seed Meal Feed	2649	1
	2900	1
Average		2
Cotton Seed Feed Meal	4162	3
Grand Ecore Cotton Oil Co., Grand Ecore, La.		
Cotton Seed Meal Feed	2895	1

SEED MEALS.*

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
41.50	40.00	13.77	8.00	24.03	26.00	6.56	8.00	7.55	6.59
42.44	40.00	9.61	8.00	30.59	26.00	9.10	8.00	2.15	6.11
42.63	40.00	8.68	8.00	24.39	26.00	8.96	8.00	8.23	7.11
43.44	40.00	8.82	8.00	24.05	26.00	8.68	8.00	7.74	7.27
43.25	40.00	8.94	8.00	24.72	26.00	8.32	8.00	7.66	7.11
42.65	40.00	9.96	8.00	25.56	26.00	8.32	8.00	6.67	6.84
46.98	41.89	9.96	8.02	24.85	23.16	6.54	10.55	6.00	5.67
48.31	41.89	9.76	8.02	23.16	23.16	6.45	10.55	6.85	5.47
45.69	41.89	9.68	8.02	24.19	23.16	7.99	10.55	6.89	5.56
49.13	41.89	8.67	8.02	24.14	23.16	6.54	10.55	5.54	5.98
47.50	41.89	8.81	8.02	23.33	23.16	6.66	10.55	7.83	5.87
47.88	41.89	9.13	8.02	23.84	23.16	6.42	10.55	6.69	6.04
47.58	41.89	9.34	8.02	23.92	23.16	6.77	10.55	6.63	5.76
49.50	40.00	9.23	8.00	17.28	26.00	7.22	8.00	11.28	5.49
48.69	42.00	8.33	8.00	23.33	24.00	6.53	7.00	7.38	5.74
48.88	42.00	6.63	8.00	23.99	24.00	6.62	7.00	8.17	5.71
48.79	42.00	7.48	8.00	23.66	24.00	6.58	7.00	7.77	5 72
43.31	40.00	10.77	9.00	24.41	26.00	6.87	8.00	8.51	6.13
43.25	40.00	10.40	9.00	24.55	26.00	7.39	8.00	8.07	6.34
43.28	40.00	10.59	9.00	24.48	26.00	7.13	8.00	8.29	6.23
43.00	42.00	10.18	9.00	24.92	23.50	8.09	5.50	7.61	6.20
42.37	33.00	12.37	12.00	23.87	18.00	7.12	12.00	7.64	6.63

---

*The color, odor and fat contents are not considered in grading these meals.

CHOICE COTTON

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Hazlehurst Oil Mill and Fertilizer Co., Hazlehurst, Miss.		
Imperial Cotton Seed Meal Feed	2204	15
	2262	11
	2437	18
	2572	21
	2735	9
	2789	4
	2887	6
	2967	5
	3054	2
	3166	9
	3284	14
	3706	23
	3978	3
	4068	8
	4168	3
	4375	6
	4489	1
	4889	6
	5011	3
	5301	1
	5071	8
	5193	2
Average		178
Jackson Cotton Oil Co., Jackson, Miss.		
Cotton Seed Meal Feed	2535	2
	2715	2
	2757	2
	2803	3
	2832	2
	3704	2
	3861	1
	4898	2
Average		16

SEED MEALS.*

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
45.38	40.00	8.28	8.00	24.78	24.00	6.88	5.00	8.39	6.29
46.00	40.00	7.90	8.00	25.36	24.00	6.70	5.00	7.63	6.41
43.81	40.00	8.10	8.00	26.04	24.00	8.76	5.00	7.14	6.15
43.69	40.00	7.73	8.00	26.66	24.00	8.15	5.00	7.67	6.10
42.64	40.00	7.69	8.00	26.31	24.00	9.00	5.00	8.17	6.19
44.00	40.00	7.28	8.00	26.81	24.00	9.06	5.00	6.69	6.16
45.06	40.00	7.49	8.00	25.84	24.00	8.08	5.00	7.15	6.38
45.31	40.00	7.40	8.00	26.04	24.00	7.55	5.00	7.43	6.27
45.69	40.00	8.54	8.00	25.71	24.00	6.87	5.00	6.89	6.30
44.06	40.00	7.80	8.00	25.76	24.00	8.02	5.00	8.02	6.34
45.19	40.00	8.02	8.00	25.70	24.00	7.52	5.00	7.11	6.46
43.56	40.00	8.45	8.00	25.49	24.00	7.28	5.00	8.46	6.76
40.75	40.00	7.86	8.00	26.79	24.00	8.78	5.00	9.01	6.81
41.81	40.00	7.97	8.00	25.48	24.00	8.30	5.00	9.85	6.59
43.88	40.00	8.41	8.00	26.22	24.00	7.23	5.00	7.55	6.71
41.94	40.00	7.74	8.00	27.10	24.00	7.93	5.00	8.77	6.52
43.81	40.00	8.98	8.00	25.79	24.00	7.07	5.00	7.83	6.52
43.25	40.00	8.62	8.00	25.39	24.00	7.90	5.00	7.95	6.89
43.25	40.00	8.78	8.00	25.53	24.00	7.16	5.00	8.41	6.87
37.50	40.00	7.69	8.00	26.96	24.00	10.71	5.00	10.69	6.42
39.44	40.00	8.39	8.00	26.53	24.00	9.86	5.00	9.57	6.21
40.06	40.00	7.85	8.00	26.69	24.00	9.27	5.00	9.78	6.35
43.19	40.00	8.04	8.00	26.05	24.00	8.09	5.00	8.19	6.44
42.26	41.00	7.87	10.00	25.12	37.00	10.47	7.50	7.64	6.64
42.43	41.00	7.28	10.00	27.37	37.00	9.19	7.50	7.30	6.43
39.75	41.00	7.22	10.00	27.04	37.00	11.10	7.50	8.66	6.23
43.19	41.00	7.93	10.00	27.28	37.00	8.02	7.50	6.86	6.72
41.63	41.00	7.71	10.00	25.53	37.00	9.72	7.50	9.13	6.28
43.69	41.00	8.43	10.00	25.71	37.00	7.06	7.50	8.15	6.96
43.19	41.00	7.64	10.00	27.06	37.00	8.13	7.50	7.71	6.27
41.06	41.00	8.86	10.00	26.40	37.00	9.40	7.50	7.74	6.54
42.15	41.00	7.87	10.00	26.44	37.00	9.13	7.50	7.90	6.51

---

*The color, odor and fat contents are not considered in grading these meals.

CHOICE COTTON

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Josey Miller Co., Beaumont, Tex.		
Cotton Seed Meal	2591	1
	2859	1
	3703	3
	4610	2
Average		7
Lecompte Cotton Oil Co., Lecompte, La.		
Cotton Seed Meal	2813	1
	2867	3
	3127	1
	3297	1
	2381	1
Average		7
Louisiana Cotton Oil Co., Shreveport, La.		
Cotton Seed Meal Feed	2406	2
	2752	1
	3003	2
	3053	2
	3092	1
	3260	5
	3435	4
	3490	3
	3735	3
	3880	2
	4188	1
	4541	1
	5101	5
	5414	1
Average		33
Magnolia Oil Mill and Manufacturing Co., Magnolia, Miss.		
Cotton Seed Meal	2248	2
	2460	1
	2508	4
	2555	5

SEED MEALS.*

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
47.37	49.18	9.72	12.28	23.25	15.81	6.33	5.86	7.80	5.53
50.88	49.18	8.35	12.38	22.43	15.81	5.47	5.86	7.42	5.45
49.50	49.18	8.11	12.38	23.12	15.81	5.70	5.86	8.16	5.41
42.88	49.18	6.15	12.38	25.23	15.81	10.60	5.86	9.52	5.62
——	——	——	——	——	——	——	——	——	——
47.66	49.18	8.08	12.38	23.51	15.81	7.03	5.86	8.22	5.50
45.44	42.93	8.15	9.05	23.41	26.83	8.05	7.80	8.27	6.68
46.19	42.93	8.47	9.05	23.46	26.83	7.26	7.80	7.76	6.86
44.13	42.93	6.40	9.05	25.76	26.83	9.89	7.80	7.83	5.99
43.75	42.93	7.13	9.05	24.32	26.83	9.06	7.80	8.62	7.12
45.19	42.93	10.06	9.05	23.48	26.83	5.85	7.80	8.37	7.05
——	——	——	——	——	——	——	——	——	——
44.94	42.93	8.04	9.05	24.09	26.83	8.02	7.80	8.17	6.74
43.88	40.00	8.92	9.40	25.36	26.60	8.56	9.00	6.78	6.50
45.56	40.00	11.59	9.40	23.13	26.60	6.42	9.00	6.44	6.86
46.50	40.00	8.58	9.40	23.07	26.60	7.15	9.00	7.47	7.23
46.44	40.00	8.18	9.40	25.17	26.60	6.82	9.00	6.42	6.97
46.94	40.00	8.06	9.40	24.26	26.60	7.39	9.00	6.39	6.96
46.38	40.00	7.93	9.40	24.39	26.60	7.84	9.00	6.92	6.54
46.56	40.00	8.07	9.40	23.61	26.60	7.29	9.00	7.88	6.59
42.43	40.00	7.84	9.40	25.57	26.60	7.30	9.00	7.92	7.94
42.75	40.00	7.87	9.40	26.98	26.60	6.89	9.00	7.53	7.98
44.06	40.00	8.12	9.40	26.31	26.60	7.31	9.00	7.52	6.68
40.13	40.00	7.59	9.40	28.84	26.60	7.40	9.00	8.45	7.59
40.56	40.00	9.03	9.40	24.39	26.60	9.08	9.00	9.55	7.39
42.56	40.00	10.88	9.40	23.44	26.60	6.82	9.00	9.52	6.78
43.75	40.00	10.46	9.40	23.42	26.60	7.50	9.00	7.95	6.92
——	——	——	——	——	——	——	——	——	——
44.18	40.00	8.79	9.40	24.93	26.60	7.41	9.00	7.62	7.07
44.38	40.00	9.80	8.00	24.83	26.00	6.06	8.00	8.24	6.69
42.69	40.00	7.44	8.00	26.65	26.00	9.48	8.00	7.38	6.36
43.94	40.00	9.12	8.00	24.91	26.00	7.14	8.00	8.40	6.49
41.69	40.00	7.90	8.00	25.94	26.00	10.16	8.00	8.13	6.18

---

*The color, odor and fat contents are not considered in grading these meals.

CHOICE COTTON

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Magnolia Oil Mill and Mfg. Co.—Continued.		
	2756	3
	2804	4
	2989	1
	3161	4
	3324	5
	5057	1
	5303	1
Average		31
Minden Cotton Oil and Ice Co., Minden, La.		
Cotton Seed Meal Feed	2853	1
	2975	1
	3139	2
	3298	1
	3456	1
	3501	1
	3672	1
	3914	1
	3979	2
	4181	1
	4326	1
	4547	1
Average		14
Minter City Oil Works, Minter City, Miss.		
Cotton Seed Meal Feed	3171	1
	3451	1
Average		2
Natchez Oil Co., Natchez, Miss.		
Cotton Seed Meal	2205	9
	2265	7
	2504	4
	2645	2
	2732	2
	2782	3

SEED MEALS.*

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
42.25	40.00	7.54	8.00	25.15	26.00	10.75	8.00	8.22	6.09
40.94	40.00	10.46	8.00	25.51	26.00	10.24	8.00	6.85	6.00
45.44	40.00	9.35	8.00	23.90	26.00	6.88	8.00	7.64	6.79
44.87	40.00	8.48	8.00	24.96	26.00	7.20	8.00	7.87	6.62
44.38	40.00	8.67	8.00	24.79	26.00	8.15	8.00	7.37	6.64
41.00	40.00	8.25	8.00	25.84	26.00	9.49	8.00	9.12	6.30
39.31	40.00	7.45	8.00	25.86	26.00	10.56	8.00	10.56	6.26
42.81	40.00	8.59	8.00	25.30	26.00	8.74	8.00	8.16	6.40
46.19	40.00	9.27	7.50	25.31	20.00	6.70	7.50	6.85	5.68
46.81	40.00	8.78	7.50	25.24	20.00	7.03	7.50	5.87	6.27
45.94	40.00	8.58	7.50	23.86	20.00	6.74	7.50	9.11	5.77
46.63	40.00	8.92	7.50	25.36	20.00	7.02	7.50	6.04	6.03
44.93	40.00	9.03	7.50	25.45	20.00	7.89	7.50	6.64	6.06
44.44	40.00	9.19	7.50	24.66	20.00	8.36	7.50	7.34	6.01
44.13	40.00	9.15	7.50	25.80	20.00	8.23	7.50	6.75	5.94
43.56	40.00	8.98	7.50	25.59	20.00	8.11	7.50	7.81	5.95
43.86	40.00	11.83	7.50	23.07	20.00	6.67	7.50	8.35	6.28
43.69	40.00	12.08	7.50	22.54	20.00	6.79	7.50	8.69	6.21
43.06	40.00	10.60	7.50	24.26	20.00	6.87	7.50	8.80	6.41
40.81	40.00	8.94	7.50	24.39	20.00	9.33	7.50	9.38	7.15
44.50	40.00	9.63	7.50	24.63	20.00	7.48	7.50	7.62	6.14
41.56	41.00	7.54	8.00	27.08	25.00	8.10	8.00	9.13	6.59
44.75	41.00	9.02	8.00	25.50	25.00	6.49	8.00	7.35	6.89
43.16	41.00	8.28	8.00	26.29	25.00	7.30	8.00	8.24	6.74
42.63	41.00	8.23	9.00	25.89	27.00	7.42	7.50	8.84	6.99
42.31	41.00	8.11	9.00	26.99	27.00	8.54	7.50	6.96	7.09
41.63	41.00	8.13	9.00	27.87	27.00	8.30	7.50	7.08	6.99
41.06	41.00	8.36	9.00	25.12	27.00	10.02	7.50	8.95	6.49
41.13	41.00	6.90	9.00	26.12	27.00	10.95	7.50	8.63	6.27
42.25	41.00	8.07	9.00	25.91	27.00	9.54	7.50	7.61	6.62

---

*The color, odor and fat contents are not considered in grading these meals.

CHOICE COTTON

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Natchez Oil Co.—Continued.		
	2846	2
	2986	2
	3169	1
	3228	1
	3400	3
	3526	3
	3593	1
	3724	2
	3957	2
	4020	2
	4867	1
	2383	4
	5226	1
	5367	1
Average		53
Natchitoches Cotton Oil Co., Natchitoches, La.		
Cotton Seed Meal	2868	2
	3762	1
Average		3
Okalona Cotton Oil Co., Okalona, Miss.		
Cotton Seed Meal Feed	3181	1
	3417	3
Average		4
People's Cotton Oil Co., Lafayette, La.		
Cotton Seed Meal Feed	2418	1
	2581	1
	2627	1
	2765	1
	3019	1
	3385	1
Average		6

SEED MEALS.*

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd	Found %	Guarant'd %	Found %	Found %
40.88	41.00	7.39	9.00	26.29	27.00	11.38	7.50	7.77	6.29
41.61	41.00	7.04	9.00	26.79	27.00	10.75	7.50	6.99	6.82
40.44	41.00	7.16	9.00	27.39	27.00	10.28	7.50	7.99	6.74
37.94	41.00	6.93	9.00	28.67	27.00	11.75	7.50	8.16	6.55
42.69	41.00	7.43	9.00	26.29	27.00	9.15	7.50	7.61	6.83
40.06	41.00	6.78	9.00	27.09	27.00	11.02	7.50	8.30	6.75
40.88	41.00	6.86	9.00	27.01	27.00	9.46	7.50	9.03	6.76
41.56	41.00	8.23	9.00	26.80	27.00	9.17	7.50	7.30	6.94
41.56	41.00	7.14	9.00	26.47	27.00	9.55	7.50	8.20	7.08
40.87	41.00	7.30	9.00	26.63	27.00	10.27	7.50	7.99	6.94
40.88	41.00	6.99	9.00	28.19	27.00	9.32	7.50	7.56	7.06
42.25	41.00	7.56	9.00	26.64	27.00	8.82	7.50	8.00	6.73
40.25	41.00	7.63	9.00	29.54	27.00	8.71	7.50	6.52	7.35
42.38	41.00	7.01	9.00	26.77	27.00	9.97	7.50	6.63	7.24
41.26	41.00	7.46	9.00	26.92	27.00	9.72	7.50	7.81	6.83
43.64	33.00	9.68	12.00	24.38	18.00	7.63	12.00	8.09	6.58
39.00	33.00	13.57	12.00	24.33	18.00	9.06	12.00	7.60	6.44
41.32	33.00	11.63	12.00	24.36	18.00	8.34	12.00	7.84	6.51
44.38	41.00	9.10	8.00	24.98	25.00	5.66	8.00	9.21	6.67
45.94	41.00	8.78	8.00	25.28	25.00	6.09	8.00	7.42	6.49
45.16	41.00	8.94	8.00	25.13	25.00	5.87	8.00	8.32	6.58
43.63	41.25	8.08	13.98	23.36	23.73	11.28	9.52	7.90	5.75
44.19	41.25	8.12	13.98	23.35	23.73	10.34	9.52	8.37	5.63
40.50	41.25	8.81	13.98	23.45	23.73	13.34	9.52	8.71	5.19
43.63	41.25	7.69	13.98	23.12	23.73	10.02	9.52	9.93	5.61
43.00	41.25	8.55	13.98	22.38	23.73	11.65	9.52	8.97	5.45
41.25	41.25	7.53	13.98	24.07	23.73	12.64	9.52	8.72	5.79
42.70	41.25	8.13	13.98	23.29	23.73	11.55	9.52	8.76	5.57

---

*The color, odor and fat contents are not considered in grading these meals.

CHOICE COTTON

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Piedmont Oil and Refining Co., Faunsdale, Ala.		
Cotton Seed Meal Feed	2669	1
Planters' Oil Mill, Monroe, La.		
Cotton Seed Meal Feed	5008	1
Cotton Seed Meal	2481	3
	2722	2
	2840	1
	3449	1
	3919	2
	4371	1
Average		10
Red River Oil Co., Alexandria, La.		
Cotton Seed Meal	2861	4
	3124	1
	3292	1
	3566	1
	3617	1
	3761	1
	4036	1
Average		10
Rodney Gin and Oil Co., Rodney, Miss.		
Cotton Seed Meal	2292	1
Ruston Oil Mill and Fertilizer Co., Ruston, La.		
Cotton Seed Meal	2441	3
	2565	3
	2968	6
	3055	2
	3253	1
	3469	5
	3634	2
	3734	16
	3834	3

SEED MEALS.*

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
41.38	40.00	9.59	10.00	25.96	27.00	8.71	8.00	8.08	6.28
45.00	45.00	9.56	7.50	25.58	20.00	6.16	10.00	6.57	7.13
40.94	42.00	10.41	8.00	25.33	15.00	8.63	10.00	8.35	6.34
43.05	42.00	9.51	8.00	25.81	15.00	7.51	10.00	7.60	6.52
43.94	42.00	9.31	8.00	26.16	15.00	7.24	10.00	6.78	6.57
42.31	42.00	8.74	8.00	25.74	15.00	8.48	10.00	8.08	6.65
41.13	42.00	9.46	8.00	25.93	15.00	8.16	10.00	8.75	6.57
38.50	42.00	15.46	8.00	24.68	15.00	7.99	10.00	7.20	6.17
41.65	42.00	10.48	8.00	25.61	15.00	8.00	10.00	7.79	6.47
40.75	30.00	10.69	7.25	25.12	35.00	8.99	25.00	8.00	6.45
43.31	30.00	8.64	7.25	24.97	35.00	8.80	25.00	7.25	7.03
39.19	30.00	12.17	7.25	23.00	35.00	11.67	25.00	7.14	6.83
43.50	30.00	8.11	7.25	25.05	35.00	9.15	25.00	7.23	6.96
42.81	30.00	8.02	7.25	25.84	35.00	9.54	25.00	7.12	6.67
40.81	30.00	8.68	7.25	25.86	35.00	10.14	25.00	7.62	6.89
41.13	30.00	9.84	7.25	24.83	35.00	9.51	25.00	7.72	6.97
41.64	30.00	9.45	7.25	24.95	35.00	9.69	25.00	7.44	6.83
41.75	38.75	6.81	8.20	23.98	25.00	11.07	9.50	9.51	6.88
44.56	40.00	10.73	8.00	25.05	26.00	6.22	8.00	7.28	6.16
45.19	40.00	7.11	8.00	25.46	26.00	6.55	8.00	9.50	6.19
41.88	40.00	9.10	8.00	26.90	26.00	8.76	8.00	7.60	5.76
43.31	40.00	9.62	8.00	26.86	26.00	7.93	8.00	6.72	5.56
37.56	40.00	7.85	8.00	26.28	26.00	11.97	8.00	10.11	6.23
44.93	40.00	7.34	8.00	26.02	26.00	7.29	8.00	8.37	6.05
41.50	40.00	7.56	8.00	25.66	26.00	9.85	8.00	9.64	5.79
45.13	40.00	8.36	8.00	26.07	26.00	6.49	8.00	7.54	6.41
46.06	40.00	8.08	8.00	25.31	26.00	6.34	8.00	8.11	6.10

---

*The color, odor and fat contents are not considered in grading these meals.

L. STATE UNIV. LIBRARY

CHOICE COTTON

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Ruston Oil Mill and Fertilizer Co.—Continued.		
	3996	7
	4064	5
	4277	2
	4434	4
	4812	1
Average		60
Shaw Oil Works, Shaw, Miss.		
Cotton Seed Meal Feed	3760	3
	3873	1
	3981	2
	4152	1
Average		7
Sonia Cotton Oil Co., Alexandria, La.		
Cotton Seed Meal Feed	2871	11
	3113	2
	3254	1
	3347	1
Average		15
Standard Cotton Seed Oil Co., New Orleans, La.		
Cotton Seed Meal	2301	1
	2417	1
	2564	1
	2903	1
	3123	1
	4419	1
	4976	1
Average		7
St. Landry Cotton Oil Co., Opelousas, La.		
Cotton Seed Meal	2862	2
	3173	1

SEED MEALS.*

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
45.32	40.00	8.13	8.00	25.18	26.00	6.66	8.00	8.63	6.08
43.81	40.00	8.56	8.00	24.32	26.00	7.09	8.00	10.14	6.08
45.06	40.00	7.77	8.00	26.98	26.00	6.82	8.00	7.23	6.14
43.44	40.00	8.48	8.00	26.80	26.00	6.85	8.00	8.29	6.14
44.88	40.00	8.57	8.00	26.18	26.00	6.95	8.00	7.32	6.10
43.76	40.00	8.38	8.00	25.93	26.00	7.55	8.00	8.32	6.06
41.88	41.00	8.36	8.00	26.85	25.00	8.43	8.00	7.71	6.77
42.43	41.00	8.06	8.00	27.19	25.00	8.28	8.00	7.29	6.75
41.38	41.00	8,23	8.00	27.05	25.00	8.39	8.00	8.34	6.61
43.06	41.00	8.52	8.00	26.32	25.00	7.19	8.00	7.95	6.96
42.19	41.00	8.29	8.00	26.86	25.00	8.07	8.00	7.82	6.77
43.88	41.20	8.52	6.62	24.44	18.00	7.73	9.00	8.30	7.13
42.81	41.20	7.55	6.62	24.90	18.00	8.91	9.00	8.78	7.05
41.00	41.20	7.14	6.62	25.98	18.00	11.31	9.00	7.67	6.90
41.88	41.20	7.44	6.62	25 98	18.00	10.68	9.00	7.03	6.99
42.39	41.20	7.66	6.62	25.33	18.00	9.66	9.00	7.95	7.02
40.94	40.00	10.73	8.00	25.00	26.00	7.75	8.00	8.19	7.39
42.88	40.00	8.90	8.00	25.84	26.00	8.48	8.00	6.42	7.48
40.73	40.00	9.74	8.00	27.37	26.00	9.29	8.00	6.68	6.19
41.69	40.00	8.30	8.00	24.98	26.00	9.04	8.00	9.24	6.75
42.63	40.00	8.58	8.00	24.28	26.00	8.55	8.00	8.72	7.24
41.94	40.00	11.10	8.00	24.19	26.00	9.11	8.00	6.75	6.91
42.81	40.00	8.26	8.00	26.42	26.00	8.70	8.00	7.24	6.57
41.95	40.00	9.37	8.00	25.44	26.00	8.70	8.00	7.61	6.93
42.69	40.00	8.87	8.50	24.59	24.00	9.21	10.50	8.54	6.10
44.44	40.00	9.26	8.50	23.02	24.00	7.29	10.50	10.10	5.89

---

*The color, odor and fat contents are not considered in grading these meals.

CHOICE COTTON

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
St. Landry Cotton Oil Co.—Continued.		
	3289	1
	3671	1
	4035	1
	4392	1
	4479	1
Average		8
St. Martin's Oil Works, St. Martinsville, La.		
Cotton Seed Meal	2663	1
	2906	1
Average		2
Sunset Cotton Oil Co., Sunset, La.		
Cotton Seed Meal	2250	2
	2484	1
	2866	2
	3291	1
	3450	1
Average		7
The Union Oil Co., Gretna, La.		
Cotton Seed Meal	2287	2
	2841	1
	2988	1
	3630	1
	4640	1
Average		6
Cotton Seed Meal Feed	2293	1
The Union Oil Co., Shreveport, La.		
Cotton Seed Meal	2482	6
	2678	2
	2759	2

SEED MEALS.*

PROTEIN		FAT		CAROHY-DRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
41.75	40.00	9.70	8.50	24.92	24.00	8.92	10.50	8.45	6.26
42.69	40.00	8.90	8.50	24.88	24.00	8.74	10.50	8.69	6.10
41.37	40.00	8.84	8.50	24.45	24.00	9.29	10.50	10.13	5.92
43.69	40.00	11.16	8.50	22.04	24.00	8.35	10.50	8.53	6.23
42.06	40.00	10.68	8.50	23.43	24.00	9.33	10.50	8.58	5.92
42.67	40.00	9.63	8.50	23.91	24.00	8.73	10.50	9.00	6.06
45.56	37.00	8.50	9.00	24.23	24.00	6.70	11.00	8.24	6.77
44.56	37.00	9.39	9.00	22.92	24.00	7.23	11.00	8.96	6.94
45.06	37.00	8.95	9.00	23.58	24.00	6.96	11.00	8.60	6.85
46.00	40.00	10.03	8.00	22.99	26.00	7.12	8.00	8.03	5.83
44.81	40.00	9.62	8.00	24.52	26.00	7.62	8.00	7.52	5.91
45.13	40.00	8.11	8.00	24.17	26.00	8.66	8.00	8.25	5.68
45.31	40.00	7.98	8.00	23.78	26.00	8.55	8.00	8.51	5.87
44.19	40.00	8.39	8.00	23.91	26.00	8.71	8.00	9.07	5.73
45.09	40.00	8.83	8.00	23.87	26.00	8.13	8.00	8.28	5.80
49.54	41.00	8.83	10.00	22.70	27.00	5.59	8.00	7.72	5.62
41.00	41.00	7.54	10.00	25.05	27.00	10.92	8.00	9.53	5.96
42.00	41.00	7.65	10.00	25.99	27.00	9.17	8.00	8.58	6.61
42.94	41.00	8.94	10.00	24.19	27.00	7.93	8.00	9.08	6.92
39.88	41.00	9.16	10.00	26.64	27.00	8.95	8.00	8.28	7.09
43.07	41.00	8.42	10.00	24.91	27.00	8.51	8.00	8.65	6.44
41.75	38.75	8.83	8.20	24.65	25.00	9.72	9.00	8.62	6.43
43.31	41.00	8.48	10.00	26.20	27.00	8.78	8.00	7.06	6.17
42.88	41.00	9.30	10.00	25.52	27.00	7.96	8.00	8.03	6.31
43.38	41.00	8.54	10.00	24.92	27.00	9.13	8.00	7.66	6.37

---

*The color, odor and fat contents are not considered in grading these meals.

CHOICE COTTON

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
The Union Oil Co.—Continued.		
	2826	3
	2913	2
	3093	1
	3409	1
	4184	1
	4535	2
	4758	3
	5060	1
Average		24
Wessor Cotton Oil Co., Wessor, Miss.		
Cotton Seed Meal Feed	3271	2
	3369	1
Average		3

PRIME COTTON

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Barber and Lewis, Edwards, Miss.		
Cotton Seed Meal Feed	2280	2
	2533	2
	3032	2
	3264	3
	3478	1
	3733	1
	4077	1
	4474	1
	4882	1
	5471	1
Average		15
Blackstone Smith, Greenwood, Miss.		
Cotton Seed Meal	5099	1

SEED MEALS.*

PROTEIN		FAT		CARBOHY-DRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
43.31	41.00	9.36	10.00	23.52	27.00	9.10	8.00	8.64	6.07
43.44	41.00	9.36	10.00	24.63	27.00	8.67	8.00	7.54	6.36
43.69	41.00	8.99	10.00	25.42	27.00	8.64	8.00	6.72	6.54
41.19	41.00	7.86	10.00	25.70	27.00	11.87	8.00	7.25	6.13
40.56	41.00	7.83	10.00	26.89	27.00	11.99	8.00	6.56	6.17
40.25	41.00	8.70	10.00	24.87	27.00	11.16	8.00	9.13	5.89
39.50	41.00	7.40	10.00	25.85	27.00	11.76	8.00	9.31	6.18
39.13	41.00	6.09	10.00	27.93	27.00	12.00	8.00	8.76	6.09
41.87	41.00	8.35	10.00	25.59	27.00	10.10	8.00	7.88	6.21
46.00	40.00	8.49	8.00	24.90	24.00	6.32	5.00	7.94	6.35
45.56	40.00	7.80	8.00	26.29	24.00	8.04	5.00	6.13	6.18
45.78	40.00	8.14	8.00	25.60	24.00	7.18	5.00	7.04	6.26

SEED MEALS.*

39.93	40.00	10.76	10.00	26.05	27.00	6.91	8.00	9.77	6.58
40.24	40.00	13.13	10.00	25.28	27.00	7.22	8.00	7.32	6.81
41.81	40.00	7.63	10.00	27.12	27.00	8.02	8.00	8.43	6.99
40.19	40.00	7.74	10.00	27.35	27.00	9.91	8.00	8.56	6.25
39.93	40.00	13.22	10.00	19.02	27.00	8.55	8.00	12.59	6.69
43.44	40.00	8.40	10.00	25.11	27.00	7.62	8.00	8.24	7.19
40.75	40.00	7.59	10.00	26.59	27.00	9.26	8.00	9.30	6.51
40.25	40.00	10.54	10.00	26.99	27.00	8.33	8.00	7.21	6.68
40.94	40.00	7.54	10.00	26.45	27.00	9.38	8.00	8.94	6.75
37.81	40.00	6.72	10.00	28.01	27.00	12.63	8.00	8.94	5.89
40.53	40.00	9.33	10.00	25.80	27.00	8.78	8.00	8.93	6.63
40.69	38.00	8.35	8.00	27.61	25.00	7.81	10.00	8.74	6.80

---

*The color, odor and fat contents are not considered in grading these meals.

PRIME COTTON

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Buckeye Cotton Oil Co., Jackson, Miss.		
Cotton Seed Meal Feed	4452	3
	4525	1
	4651	1
	4683	1
	5055	1
	5083	1
	—	—
Average		8
Brookhaven Cotton Oil Co., Brookhaven, Miss.		
Cotton Seed Meal	2342	2
	2503	5
	2673	2
	2819	1
	2925	1
	5052	1
	5438	3
	—	—
Average		15
Capital City Oil Co., Baton Rouge, La.		
Cotton Seed Meal	2806	1
	3300	1
	3457	1
	2380	1
	—	—
Average		4
Cotton Seed Meal Feed	2202	8
	2644	1
	—	—
Average		9
Central Cotton Oil Co., Jackson, Miss.		
Cotton Seed Meal Feed	2651	1
	2374	1
	5177	1
	5202	1
	—	—
Average		4

SEED MEALS.*

PROTEIN		FAT		CARBOHY-DRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
40.94	41.00	8.45	10.00	25.32	27.00	10.90	8.00	8.10	6.29
39.00	41.00	7.73	10.00	26.45	27.00	12.85	8.00	7.93	6.04
41.88	41.00	8.43	10.00	26.19	27.00	9.25	8.00	7.54	6.71
41.81	41.00	7.49	10.00	27.23	27.00	10.36	8.00	6.46	6.65
40.19	41.00	8.62	10.00	26.64	27.00	8.88	8.00	9.16	6.51
41.38	41.00	9.70	10.00	25.46	27.00	7.56	8.00	9.28	6.62
40.87	41.00	8.40	10.00	26.21	27.00	9.97	8.00	8.08	6.47
39.75	38.50	7.73	7.00	26.40	25.00	11.21	10.00	8.92	5.99
40.11	38.50	7.21	7.00	27.38	25.00	11.20	10.00	8.34	5.76
39.44	38.50	7.20	7.00	29.65	25.00	10.11	10.00	7.72	5.88
43.63	38.50	6.88	7.00	27.33	25.00	9.35	10.00	6.47	6.34
42.00	38.50	6.89	7.00	28.10	25.00	10.50	10.00	6.50	6.01
41.38	38.50	7.11	7.00	27.11	25.00	10.08	10.00	7.96	6.36
37.81	38.50	6.64	7.00	29.40	25.00	11.73	10.00	8.22	6.20
40.59	38.50	7.09	7.00	27.91	25.00	10.60	10.00	7.73	6.08
39.00	40.00	6.64	7.00	28.30	26.00	11.88	8.00	7.62	6.56
38.75	40.00	7.49	7.00	28.13	26.00	11.33	8.00	7.33	6.97
38.94	40.00	6.63	7.00	27.51	26.00	11.94	8.00	8.19	6.79
40.56	40.00	8.93	7.00	24.65	26.00	10.57	8.00	8.92	6.37
39.31	40.00	7.42	7.00	27.15	26.00	11.43	8.00	8.02	6.67
36.94	34.50	7.67	6.50	26.13	28.00	13.55	12.00	9.40	6.31
41.53	34.50	7.70	6.50	25.60	28.00	9.57	12.00	8.74	6.86
39.24	34.50	7.68	6.50	25.87	28.00	11.56	12.00	9.07	6.58
41.38	39.00	11.09	10.00	24.52	27.50	8.55	8.50	8.22	6.24
40.63	39.00	10.55	10.00	26.70	27.50	7.37	8.50	8.20	6.55
39.44	39.00	8.60	10.00	27.69	27.50	9.34	8.50	8.45	6.48
39.38	39.00	8.69	10.00	26.28	27.50	10.16	8.50	9.07	6.42
40.20	39.00	9.74	10.00	26.29	27.50	8.87	8.50	8.48	6.42

---

*The color, odor and fat contents are not considered in grading these meals.

PRIME COTTON

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Clinton Cotton Oil and Mfg. Co., Clinton, La.		
Cotton Seed Meal	2284	3
	2514	1
Average		4
Columbia Cotton Oil and Mfg. Co., New Orleans, La.		
Cotton Seed Meal Feed	2360	2
	2578	2
	2703	1
	3368	1
	3567	1
	4471	1
	5456	1
Average		9
Concordia Oil Mill Co., Vidalia, La.		
Cotton Seed Meal	2223	4
	2405	2
	2589	1
	2767	1
	3503	1
	4149	1
Average		10
Feliciana Oil Co., St. Francisville, La.		
Cotton Seed Meal Feed	2972	1
	3296	1
	3635	1
Average		3
Lake Providence Cotton Oil Co., Lake Providence, La.		
Cotton Seed Meal	2764	1
	4198	1
Average		2

SEED MEALS.*

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
39.69	38.00	11.46	10.00	25.07	21.00	8.78	9.00	8.83	6.17
39.54	38.00	15.21	10.00	25.15	21.00	7.64	9.00	6.54	5.92
39.62	38.00	13.33	10.00	25.11	21.00	8.21	9.00	7.68	6.05
40.56	30.00	8.26	8.00	25.43	25.00	9.98	10.00	8.62	7.15
40.78	30.00	9.50	8.00	24.21	25.00	9.47	10.00	9.63	6.41
39.19	30.00	9.39	8.00	25.19	25.00	9.13	10.00	10.85	6.25
41.31	30.00	9.07	8.00	26.00	25.00	10.11	10.00	6.70	6.81
40.31	30.00	9.06	8.00	25.14	25.00	10.01	10.00	8.78	6.70
39.44	30.00	8.81	8.00	28.05	25.00	9.65	10.00	6.90	7.15
39.13	30.00	3.64	8.00	29.00	25.00	11.47	10.00	9.79	6.97
40.10	30.00	8.25	8.00	26.15	25.00	9.97	10.00	8.76	6.77
40.50	40.00	10.37	6.00	25.86	27.00	7.07	8.00	9.24	6.96
40.69	40.00	14.83	6.00	24.74	27.00	6.65	8.00	6.56	6.53
39.50	40.00	8.02	6.00	27.54	27.00	10.07	8.00	8.47	6.40
43.69	40.00	9.50	6.00	25.37	27.00	6.35	8.00	8.13	6.96
42.63	40.00	9.21	6.00	26.09	27.00	6.95	8.00	7.54	7.58
39.63	40.00	8.52	6.00	26.37	27.00	9.25	8.00	9.50	6.73
41.10	40.00	10.09	6.00	25.99	27.00	7.72	8.00	8.24	6.86
38.50	40.00	7.52	8.00	27.63	26.00	11.64	3.00	8.33	6.38
38.06	40.00	8.12	8.00	27.16	26.00	12.22	3.00	8.40	6.04
40.44	40.00	8.94	8.00	26.03	26.00	9.61	3.00	8.24	6.74
39.00	40.00	8.19	8.00	26.94	26.00	11.16	3.00	8.32	6.39
41.13	40.00	9.36	8.00	26.77	26.00	7.11	8.00	8.35	7.28
38.31	40.00	11.07	8.00	25.56	26.00	9.29	8.00	8.76	7.01
39.72	40.00	10.22	8.00	26.17	26.00	8.20	8.00	8.55	7.14

---

*The color, odor and fat contents are not considered in grading these meals.

PRIME COTTON

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Longbridge Cotton Oil Co., Longbridge, La.		
Cotton Seed Meal Feed	2348	1
	2869	2
	4125	1
Average		4
Mississippi Cotton Oil Co., Jackson, Miss.		
Cotton Seed Meal	2462	1
	2668	1
Average		2
Mississippi Cotton Oil Co., Natchez, Miss.		
Cotton Seed Meal	2766	1
	2924	1
	3502	1
	3618	1
Average		4
Mississippi Cotton Oil Co., Yazoo City, Miss.		
Cotton Seed Meal Feed	3224	1
New Roads Oil Mill and Mfg. Co., New Roads, La.		
Cotton Seed Meal Feed	2349	1
	3568	1
	4325	2
	4476	1
	4698	1
Average		6
Orleans Cotton Oil Co., New Orleans, La.		
Cotton Seed Meal Feed	2425	1
	2622	1
	2805	1
	3233	1
	3621	1
	4990	1
	5292	1
Average		7

SEED MEALS.*

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
40.56	33.00	7.83	9.00	27.13	27.00	9.33	11.00	8.39	6.76
39.31	33.00	7.01	9.00	27.65	27.00	11.26	11.00	7.93	6.84
37.94	33.00	6.61	9.00	28.46	27.00	12.48	11.00	7.77	6.74
39.27	33.00	7.15	9.00	27.75	27.00	11.02	11.00	8.03	6.78
41.94	38.63	9.10	10.00	26.61	27.37	8.49	9.00	7.53	6.33
40.06	38.63	6.90	10.00	28.38	27.37	10.60	9.00	8.45	5.61
41.00	38.63	8.00	10.00	27.49	27.37	9.55	9.00	7.99	5.97
41.44	38.63	9.57	10.00	24.53	27.37	8.73	9.00	9.08	6.65
40.88	38.63	8.39	10.00	26.66	27.37	8.70	9.00	8.58	6.79
38.88	38.63	14.39	10.00	24.98	27.37	8.62	9.00	6.67	6.46
41.75	38.63	7.93	10.00	26.40	27.37	9.20	9.00	7.96	6.76
40.74	38.63	10.07	10.00	25.64	27.37	8.81	9.00	8.07	6.67
39.56	38.63	8.22	10.00	26.66	27.37	9.96	9.00	8.95	6.65
38.13	37.62	13.52	12.50	24.30	25.99	9.19	9.00	7.92	6.94
38.75	37.62	8.92	12.50	24.93	25.99	11.86	9.00	8.48	7.06
38.69	37.62	11.15	12.50	23.94	25.99	9.17	9.00	9.91	7.14
36.94	37.62	7.76	12.50	27.13	25.99	12.43	9.00	8.89	6.85
42.69	37.62	9.69	12.50	24.63	25.99	8.87	9.00	7.94	6.18
39.04	37.62	10.21	12.50	24.99	25.99	10.30	9.00	8.63	6.83
38.69	33.00	7.17	9.00	26.86	27.00	12.55	11.00	8.04	6.69
38.25	33.00	7.44	9.00	28.17	27.00	11.98	11.00	7.44	6.72
37.13	33.00	6.95	9.00	28.80	27.00	13.50	11.00	7.44	6.18
39.38	33.00	6.58	9.00	25.11	27.00	11.21	11.00	11.31	6.41
41.44	33.00	7.50	9.00	26.55	27.00	10.45	11.00	7.33	6.73
38.44	33.00	7.74	9.00	28.65	27.00	11.12	11.00	7.56	6.49
40.06	33.00	8.01	9.00	28.73	27.00	9.92	11.00	6.38	6.90
39.06	33.00	7.34	9.00	27.55	27.00	11.53	11.00	7.93	6.59

---

*The color, odor and fat contents are not considered in grading these meals.

PRIME COTTON

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Planters' Oil Mill, Tunica, Miss.		
Cotton Seed Meal Feed	3434	2
Port Gibson Oil Works, Port Gibson, Miss.		
Cotton Seed Meal	2643	1
	2966	3
	3705	3
	3988	1
	4065	2
	4170	3
	4366	1
	4427	3
	4858	2
Average		19
Refuge Cotton Oil Co., Columbus, Miss.		
Cotton Seed Meal	5062	1
	5448	3
Average		4
The Union Oil Co., Bunkie, La.		
Bunkie Mill Cotton Seed Meal Feed	2863	6
	3299	1
	3477	1
	3863	1
Average		9
The Union Oil Co., Monroe, La.		
Cotton Seed Meal	2466	2
	2620	1
	2905	1
	2964	2
	3455	1
	3924	2
	4364	1
Average		10

SEED MEALS.*

PROTEIN		FAT		CARBOHY-DRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
39.31	41.00	8.54	8.00	27.74	25.00	9.59	8.00	7.61	7.21
40.51	38.00	8.73	8.00	27.17	32.00	9.06	11.00	7.75	6.78
40.69	38.00	7.86	8.00	27.50	32.00	9.48	11.00	7.66	6.81
38.81	38.00	8.00	8.00	27.09	32.00	10.94	11.00	8.51	6.65
37.50	38.00	8.86	8.00	28.62	32.00	10.00	11.00	8.40	6.62
38.44	38.00	10.08	8.00	25.67	32.00	9.81	11.00	9.54	6.46
39.63	38.00	8.89	8.00	26.86	32.00	10.04	11.00	7.79	6.79
39.19	38.00	9.19	8.00	27.34	32.00	9.08	11.00	8.18	7.02
39.00	38.00	8.71	8.00	28.01	32.00	10.34	11.00	7.41	6.53
35.88	38.00	9.38	8.00	27.91	32.00	10.90	11.00	9.39	6.54
38.85	38.00	8.86	8.00	27.35	32.00	9.96	11.00	8.29	6.69
40.88	40.00	6.21	8.00	31.09	25.00	7.96	10.00	7.65	6.21
40.31	40.00	9.19	8.00	26.90	25.00	8.60	10.00	8.22	6.78
40.59	40.00	7.70	8.00	29.00	25.00	8.28	10.00	7.93	6.50
40.13	33.00	9.22	9.00	25.03	27.00	10.96	11.00	8.18	6.48
38.44	33.00	7.63	9.00	25.73	27.00	12.99	11.00	8.88	6.33
34.87	33.00	10.81	9.00	26.25	27.00	14.28	11.00	7.74	6.05
41.25	33.00	7.74	9.00	26.52	27.00	10.87	11.00	7.20	6.42
38.68	33.00	8.85	9.00	25.88	27.00	12.27	11.00	8.00	6.32
41.75	41.00	8.68	10.00	26.96	27.00	8.80	8.00	7.45	6.36
43.13	41.00	8.45	10.00	23.98	27.00	8.62	8.00	9.37	6.45
40.50	41.00	9.50	10.00	26.67	27.00	9.71	8.00	7.29	6.38
39.63	41.00	6.81	10.00	28.04	27.00	10.94	8.00	8.37	6.21
42.81	41.00	7.38	10.00	26.83	27.00	7.99	8.00	7.96	7.03
40.13	41.00	7.74	10.00	25.98	27.00	10.82	8.00	9.10	6.23
38.69	41.00	15.51	10.00	25.52	27.00	7.87	8.00	6.17	6.24
40.95	41.00	9.15	10.00	26.28	27.00	9.25	8.00	7.96	6.41

---

*The color, odor and fat contents are not considered in grading these meals.

PRIME COTTON

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
The Union Oil Co., Torras, La.		
Cotton Seed Meal	2350	1
	3383	1
Average		2
The Union Oil Co., Vidalia, La.		
Cotton Seed Meal	2499	2
	3636	1
	4123	1
	5378	1
Average		5
Washington Cotton Oil Co., Washington, La.		
Cotton Seed Meal	2864	3
	3290	1
	4681	1
	4736	1
	4932	1
	5092	1
Average		8
J. Lindsay Wells, Memphis, Tenn.		
Cotton Seed Meal "Star"	2323	1
	3388	2
	4321	1
	4415	1
	4926	1
	5302	1
Average		7

SEED MEALS.*

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
42.81	41.00	8.46	10.00	26.42	27.00	8.19	8.00	6.63	7.49
37.50	41.00	7.04	10.00	28.19	27.00	13.28	8.00	7.30	6.69
———	———	———	———	———	———	———	———	———	———
40.15	41.00	7.75	10.00	27.30	27.00	10.74	8.00	6.97	7.09
38.57	41.00	11.76	10.00	26.00	27.00	9.00	8.00	8.15	6.52
35.31	41.00	8.50	10.00	26.50	27.00	13.34	8.00	9.79	6.56
40.50	41.00	8.57	10.00	26.09	27.00	8.10	8.00	9.68	7.06
39.75	41.00	9.11	10.00	27.02	27.00	8.47	8.00	8.17	7.48
———	———	———	———	———	———	———	———	———	———
38.53	41.00	9.49	10.00	26.40	27.00	9.73	8.00	8.95	6.90
41.50	35.00	10.74	8.00	24.56	25.00	8.99	12.00	8.20	6.01
41.63	35.00	9.32	8.00	25.64	25.00	9.57	12.00	7.84	6.00
39.93	35.00	8.12	8.00	25.13	25.00	10.98	12.00	9.79	6.05
40.44	35.00	8.26	8.00	25.38	25.00	10.32	12.00	9.65	5.95
39.50	35.00	8.23	8.00	26.58	25.00	10.67	12.00	9.10	5.92
39.06	35.00	10.16	8.00	25.28	25.00	10.51	12.00	9.01	5.98
———	———	———	———	———	———	———	———	———	———
40.34	35.00	9.14	8.00	25.43	25.00	10.17	12.00	8.93	5.99
41.63	41.00	10.47	9.00	23.36	25.00	9.13	7.00	8.54	6.87
39.06	41.00	9.30	9.00	27.68	25.00	9.50	7.00	7.50	6.96
39.56	41.00	7.09	9.00	27.36	25.00	10.44	7.00	9.08	6.47
46.85	41.00	9.17	9.00	21.10	25.00	9.15	7.00	7.51	6.22
32.06	41.00	10.52	9.00	28.83	25.00	13.80	7.00	8.65	6.14
40.19	41.00	8.80	9.00	26.08	25.00	7.81	7.00	10.16	6.96
———	———	———	———	———	———	———	———	———	———
39.89	41.00	9.22	9.00	25.73	25.00	9.99	7.00	8.57	6.60

*The color, odor and fat contents are not considered in grading these meals.

GOOD COTTON

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Buckeye Cotton Oil Co., Jackson, Miss.		
Cotton Seed Meal Feed, Off Grade	4523	2
Madison Cotton Oil Co., Tallulah, La.		
Cotton Seed Meal Feed	2486	1
	3042	1
	3620	1
	3980	2
	5129	2
Average		7
Tensas Cotton Oil and Mfg. Co., St. Joseph, La.		
Cotton Seed Meal Feed	2897	1
	3530	1
	4503	1
Average		3

COTTON SEED

Tennesse Fiber Co., Memphis, Tenn.		
Cotton Seed Meal Feed, "Creamo"	2367	2
	2740	1
	2839	1
	3759	3
	3815	3
	3879	3
	4883	1
	4971	1
	5015	2
Average		17
J. Lindsay Wells Co., Memphis, Tenn.		
Cotton Seed Meal, "Sunny South"	2665	1
	2965	3
	3125	1
	4925	1
Average		6

SEED MEALS.*

PROTEIN		FAT		CARBOHY-DRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant,d %	Found %	Guarant'd %	Found %	Found %
37.50	22.00	8.90	5.60	27.82	33.00	11.08	23.00	8.70	6.00
38.94	40.00	6.96	8.00	28.59	26.00	9.84	8.00	8.75	6.92
38.19	40.00	8.01	8.00	29.14	26.00	11.00	8.00	6.67	6.99
32.75	40.00	7.49	8.00	35.43	26.00	10.11	8.00	7.82	6.40
36.31	40.00	7.38	8.00	27.55	26.00	12.49	8.00	9.39	6.88
34.25	40.00	7.61	8.00	27.30	26.00	11.66	8.00	11.98	7.20
36.09	40.00	7.49	8.00	29.60	26.00	11.02	8.00	8.92	6.88
37.81	40.00	11.14	8.00	23.94	26.00	12.49	8.00	7.82	6.80
37.63	40.00	10.68	8.00	27.12	26.00	9.19	8.00	8.35	7.03
38.69	40.00	10.12	8.00	26.56	26.00	9.40	8.00	8.15	7.08
38.04	40.00	10.65	8.00	25.87	26.00	10.36	8.00	8.11	6.97

FEEDS.

26.06	22.00	5.63	5.00	35.33	38.00	19.50	28.00	8.85	4.63
23.11	22.00	5.97	5.00	36.17	38.00	21.43	28.00	9.25	4.07
18.88	22.00	3.93	5.00	38.38	38.00	24.91	28.00	9.89	4.01
24.38	22.00	4.60	5.00	35.91	38.00	21.06	28.00	9.14	4.91
21.31	22.00	4.15	5.00	37.01	38.00	24.16	28.00	9.01	4.36
21.94	22.00	4.44	5.00	37.15	38.00	22.58	28.00	9.07	4.82
22.13	22.00	4.03	5.00	36.66	38.00	22.67	28.00	9.80	4.71
22.13	22.00	4.98	5.00	37.10	38.00	21.73	28.00	9.28	4.78
23.06	22.00	5.18	5.00	36.02	38.00	22.01	28.00	8.78	4.95
22.55	22.00	4.77	5.00	36.64	38.00	22.23	28.00	9.23	4.58
23.50	24.00	4.42	5.00	36.26	32.00	21.68	22.00	10.14	4.06
20.94	24.00	4.24	5.00	38.51	32.00	23.21	22.00	8.88	4.22
26.00	24.00	9.14	5.00	32.73	32.00	17.87	22.00	9.42	4.84
20.13	24.00	4.60	5.00	37.59	32.00	24.63	22.00	8.53	4.52
22.64	24.00	5.60	5.00	36.27	32.00	21.85	22.00	9.24	4.40

---

*The color, odor and fat contents are not considered in grading these meals.

RICE

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Abbeville Rice Milling Co., Abbeville, La.		
Rice Bran	2320	1
	3008	1
	3221	1
Average		3
American Rice Milling Co., Crowley, La.		
Rice Bran	2304	2
	2467	3
	2630	2
	2701	1
	2858	1
	2936	1
	3090	1
	3745	1
Average		12
Conover Rice Milling Co., Mermenteau, La.		
Rice Bran	2332	1
	2476	2
	2901	1
	3596	1
Average		5
Crowley Rice Milling Co., Crowley, La.		
Rice Bran	2286	2
	2468	4
	2638	1
	2718	1
	2771	1
	2930	2
	3344	2
	3637	1
	4033	1
Average		15
Bolted Rice Bran	2325	1

BRANS.

PROTEIN		FAT		CARBOHY-DRATES		FIBER		Water	Ash	Hulls
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found	Guarant'd %	Found %	Found %	Found %
12.06	10.00	8.97	10.00	49.64	35.00	9.15	15.00	11.16	9.02	
13.38	10.00	13.27	10.00	41.22	35.00	10.19	15.00	10.98	10.96	
13.44	10.00	12.57	10.00	43.65	35.00	10.07	15.00	10.91	9.36	
12.96	10.00	11.60	10.00	44.84	35.00	9.80	15.00	11.02	9.78	None
11.63	10.75	8.87	8.95	49.03	48.66	10.79	10.85	9.99	9.69	
12.75	10.75	11.96	8.95	42.85	48.66	11.14	10.85	10.79	10.51	
13.18	10.75	13.63	8.95	41.30	48.66	11.72	10.85	9.28	10.89	
12.31	10.75	10.36	8.95	45.35	48.66	10.37	10.85	12.12	9.49	
11.94	10.75	11.38	8.95	46.23	48.66	9.91	10.85	11.28	9.26	
12.63	10.75	11.24	8.95	45.51	48.66	9.52	10.85	12.72	8.38	
12.75	10.75	14.80	8.95	37.62	48.66	12.71	10.85	11.64	10.48	
12.31	10.75	9.42	8.95	45.90	48.66	9.00	10.85	10.12	13.25	
12.44	10.75	11.46	8.95	44.22	48.66	10.65	10.85	10.99	10.24	2.16
12.63	10.50	10.04	9.50	51.37	40.00	8.69	18.00	10.59	6.68	
13.25	10.50	13.20	9.50	48.12	40.00	8.05	18.00	10.23	7.15	
13.69	10.50	12.20	9.50	49.91	40.00	7.37	18.00	9.40	7.43	
12.63	10.50	9.88	9.50	48.32	40.00	8.10	18.00	13.89	7.18	
13.05	10.50	11.33	9.50	49.43	40.00	8.05	18.00	11.03	7.11	None
11.88	11.37	10.18	10.00	49.54	47.55	10.78	14.25	9.44	8.18	
10.81	11.37	8.12	10.00	50.47	47.55	11.77	14.25	10.62	8.21	
12.00	11.37	9.97	10.00	48.63	47.55	10.64	14.25	11.13	7.63	
11.68	11.37	9.27	10.00	45.83	47.55	12.01	14.25	13.47	7.74	
12.00	11.37	9.53	10.00	45.81	47.55	10.80	14.25	13.97	7.89	
12.31	11.37	10.40	10.00	45.65	47.55	12.73	14.25	10.08	8.83	
11.94	11.37	8.68	10.00	49.96	47.55	10.43	14.25	11.03	7.96	
11.50	11.37	6.26	10.00	48.20	47.55	15.52	14.25	11.13	7.39	
11.31	11.37	9.47	10.00	46.61	47.55	12.55	14.25	10.77	9.29	
11.72	11.37	9.10	10.00	47.86	47.55	11.91	14.25	11.29	8.12	6.36
12.25	14.00	10.20	12.45	55.62	52.59	5.75	6.50	10.24	5.94	None

RICE

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Donaldsonville Rice Mill, Donaldsonville, La.		
Rice Bran	2238 2459	2 1
Average		3
Empire Rice Mill Co., New Orleans, La.		
Rice Bran	2199 2276 2554 2699 2970 3115 3682 3765 3949	5 2 1 1 1 2 1 1 1
Average		15
Eureka Rice Mill, Esterwood, La.		
Rice Bran	2249 2601	2 1
Average		3
B. F. Glover and Sons Com. Co., New Orleans, La.		
"New Basin" Rice Bran	2551 2712 2980 3202 3277 2368	1 2 1 1 2 3
Average		10
J. S. Gordon and Co., Beaumont, Tex.		
Rice Bran, "Mixed"	4646	1

BRANS.

PROTEIN		FAT		CARBOHY-DRATES		FIBER		Water	Ash	Hulls
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %	Found %
12.06	13.81	11.75	10.49	40.56	38.05	14.15	15.12	9.08	12.40	
13.44	13.81	11.26	10.49	37.86	38.05	15.68	15.12	8.63	13.11	
12.75	13.81	11.51	10.49	39.21	38.05	14.92	15.12	8.86	12.75	16.38
12.13	11.39	11.20	10.50	46.91	44.80	9.97	12.50	10.65	9.14	
12.31	11.39	10.73	10.50	47.67	44.80	10.54	12.50	10.46	8.29	
10.31	11.39	9.00	10.50	49.88	44.80	10.44	12.50	11.20	9.17	
11.31	11.39	10.19	10.50	44.21	44.80	13.54	12.50	10.80	9.95	
12.94	11.39	12.32	10.50	44.10	44.80	12.13	12.50	9.83	8.68	
12.44	11.39	11.09	10.50	42.35	44.80	11.98	12.50	11.30	10.84	
11.44	11.39	9.03	10.50	47.02	44.80	11.49	12.50	12.03	8.98	
13.50	11.39	11.70	10.50	47.79	44.80	10.24	12.50	8.52	8.25	
12.13	11.39	5.76	10.50	44.92	44.80	12.72	12.50	12.22	12.25	
12.06	11.39	10.11	10.50	46.09	44.80	11.45	12.50	10.78	9.51	4.83
11.88	10.50	9.82	12.09	52.09	53.41	8.87	9.18	9.93	7.41	
13.28	10.50	11.93	12.09	42.55	53.41	12.02	9.18	10.46	9.76	
12.56	10.50	10.88	12.09	47.32	53.41	10.45	9.18	10.20	8.59	1.50
7.39	8.08	4.78	8.65	36.57	37.08	26.63	23.81	9.31	15.32	
5.68	8.08	2.53	8.65	33.84	37.08	31.07	23.81	9.73	17.15	
4.75	8.08	2.49	8.65	30.98	37.08	34.22	23.81	9.56	18.00	
4.50	8.08	1.63	8.65	31.29	37.08	34.07	23.81	10.04	18.47	
4.63	8.08	0.98	8.65	29.09	37.08	37.87	23.81	8.89	18.54	
7.21	8.08	4.45	8.65	35.63	37.08	28.22	23.81	9.43	15.06	
5.69	8.08	2.81	8.65	32.91	37.08	32.01	23.81	9.49	17.09	73.29
13.88	12.00	3.98	4.00	50.20	50.00	13.69	10.00	10.19	8.06	12.29

RICE

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Gueydan Rice Milling Co., Gueydan, La.		
Rice Bran	3007	1
	2377	1
Average		2
Gulf Rice Milling Co., Welsh, La.		
Rice Bran	2232	2
	2359	2
	2518	1
	2773	1
	2922	1
	3006	1
	3088	1
	3126	1
	3362	1
Average		11
Haspel and Davis, New Orleans, La.		
Rice Bran	2423	1
	2625	1
	2739	1
	3089	1
Average		4
Ida Rice Mill, Rayne, La.		
Rice Bran	2251	2
	2354	1
	2488	1
	2650	1
Average		5
Iota Rice Milling Co., Iota, La.		
Rice Bran	2305	2
	2652	1
	2878	1
	3145	1
Average		5

BRANS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		Water	Ash	Hulls
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %	Found %
13.00	11.94	11.96	14.75	44.16	45.41	8.24	9.52	15.11	7.53	
12.43	11.94	10.38	14.75	53.14	45.41	7.54	9.52	10.06	6.45	
12.71	11.94	11.17	14.75	48.65	45.41	7.89	9.52	12.59	6.99	None
14.25	9.10	13.62	8.50	46.65	40.00	8.94	21.00	9.23	7.31	
13.00	9.10	12.67	8.50	45.51	40.00	11.23	21.00	9.50	8.09	
14.03	9.10	14.03	8.50	43.36	40.00	10.24	21.00	11.35	6.99	
13.38	9.10	12.47	8.50	42.69	40.00	9.38	21.00	13.74	8.34	
13.88	9.10	14.60	8.50	41.41	40.00	10.64	21.00	9.59	9.88	
13.63	9.10	13.46	8.50	42.45	40.00	9.60	21.00	11.99	8.87	
14.13	9.10	11.78	8.50	45.65	40.00	9.84	21.00	10.63	7.97	
13.31	9.10	11.19	8.50	46.54	40.00	8.28	21.00	13.40	7.28	
13.75	9.10	10.76	8.50	43.06	40.00	10.51	21.00	13.62	8.30	
13.71	9.10	12.73	8.50	44.15	40.00	9.85	21.00	11.45	8.11	None
11.13	10.06	11.12	12.00	41.37	45.57	16.47	11.40	8.79	11.12	
9.81	10.06	9.90	12.00	38.67	45.57	19.16	11.40	10.21	12.25	
11.79	10.06	11.97	12.00	32.67	45.57	16.12	11.40	14.29	13.16	
11.25	10.06	6.89	12.00	45.61	45.57	13.76	11.40	14.04	8.45	
10.99	10.06	9.97	12.00	39.58	45.57	16.38	11.40	11.83	11.25	21.25
10.50	11.37	8.73	9.80	45.25	44.05	15.50	14.25	9.10	10.92	
11.69	11.37	9.14	9.80	44.31	44.05	14.45	14.25	10.40	10.01	
10.25	11.37	7.11	9.80	49.05	44.05	12.73	14.25	11.28	9.58	
10.79	11.37	8.41	9.80	43.37	44.05	15.15	14.25	11.77	10.51	
10.81	11.37	8.35	9.80	45.50	44.05	14.45	14.25	10.64	10.25	14.82
13.19	10.00	11.89	11.00	49.57	42.00	8.35	15.00	10.13	6.87	
12.61	10.00	10.94	11.00	48.24	42.00	10.11	15.00	10.97	7.13	
12.94	10.00	11.72	11.00	45.03	42.00	11.24	15.00	10.75	8.32	
12.25	10.00	10.93	11.00	44.60	42.00	11.44	15.00	12.20	8.58	
12.75	10.00	11.37	11.00	46.86	42.00	10.28	15.00	11.01	7.73	0.93

RICE

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Jennings Rice Milling Co., Jennings, La.		
Rice Bran	2233	2
	2640	1
	3122	1
	3371	1
	4261	1
Average		6
Jennings Rice Milling Co., Welsh, La.		
Rice Bran	2234	2
	2639	1
	3005	1
	3360	1
	3990	1
Average		6
Jones Bros., Crowley, La.		
Rice Bran	2316	1
Lake Arthur Rice Milling Co., Lake Arthur, La.		
Rice Bran	2330	1
	2483	1
	2641	1
	3444	1
	3803	1
Average		5
Lake Charles Rice Milling Co., Lake Charles, La.		
Rice Bran	2314	1
	2595	1
	3091	1
	3476	1
	3909	1
Average		5

BRANS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		Water	Ash	Hulls
Found %	Guarant'd	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %	Found %
13.50	13.00	13.53	15.00	45.92	41.00	9.34	8.00	9.15	8.56	
14.50	13.00	14.28	15.00	41.81	41.00	8.57	8.00	11.81	9.03	
14.88	13.00	16.01	15.00	40.18	41.00	9.66	8.00	11.63	7.64	
14.25	13.00	15.48	15.00	42.45	41.00	9.27	8.00	10.54	8.01	
14.75	13.00	15.04	15.00	44.16	41.00	9.49	8.00	8.15	8.41	
——	——	——	——	——	——	——	——	——	——	——
14.38	13.00	14.86	15.00	42.90	41.00	9.27	8.00	10.26	8.33	None
13.81	13.00	14.22	15.00	42.40	41.00	12.68	8.00	9.24	7.65	
15.34	13.00	13.05	15.00	44.13	41.00	8.60	8.00	10.86	8.02	
14.38	13.00	16.18	15.00	43.43	41.00	7.15	8.00	11.11	7.75	
14.93	13.00	14.91	15.00	43.75	41.00	7.84	8.00	9.82	8.75	
13.56	13.00	11.40	15.00	52.08	41.00	8.77	8.00	9.72	4.47	
——	——	——	——	——	——	——	——	——	——	——
14.40	13.00	13.95	15.00	45.16	41.00	9.01	8.00	10.15	7.33	None
10.00	10.00	7.37	12.00	44.43	42.00	15.59	15.00	11.03	11.58	18.61
13.44	10.50	11.16	9.50	46.96	40.00	9.36	18.00	9.92	9.16	
12.43	10.50	12.69	9.50	50.25	40.00	7.82	18.00	10.23	6.58	
13.25	10.50	12.38	9.50	47.15	40.00	8.56	18.00	11.19	7.47	
13.38	10.50	13.88	9.50	42.95	40.00	10.44	18.00	10.77	8.58	
13.38	10.50	13.15	9.50	43.81	40.00	8.88	18.00	12.57	8.21	
——	——	——	——	——	——	——	——	——	——	——
13.18	10.50	12.65	9.50	46.22	40.00	9.01	18.00	10.94	8.00	None
13.31	8.00	12.70	8.00	43.97	35.00	11.61	25.00	10.50	7.91	
11.81	8.00	11.13	8.00	43.73	35.00	13.41	25.00	10.87	9.05	
11.63	8.00	10.76	8.00	42.00	35.00	13.57	25.00	12.75	9.29	
11.50	8.00	10.55	8.00	43.70	35.00	14.15	25.00	10.78	9.32	
10.69	8.00	9.40	8.00	41.46	35.00	17.69	25.00	9.29	11.47	
——	——	——	——	——	——	——	——	——	——	——
11.79	8.00	10.91	8.00	42.97	35.00	14.09	25.00	10.83	9.41	13.62

RICE

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Leona Rice Milling Co., New Orleans, La.		
Rice Bran	2361	2
	2923	1
	3305	1
	3548	1
	3736	3
	4006	1
	5350	2
Average		11
Levy's Rice Mill, New Orleans, La.		
Rice Bran	2353	1
	3453	1
Average		2
Midland Rice Mill, Midland, La.		
Rice Bran	2334	1
Morse Rice Mill Co., Ltd., Morse, La.		
Rice Bran	2324	1
Mutual Rice Mill, Gueydan, La.		
Rice Bran	2600	1
	3009	1
	4122	1
Average		3
National Rice Milling Co., Crowley, La.		
Rice Bran	2333	1
	2780	1
	3361	1
Average		3

BRANS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		Water	Ash	Hulls
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	%	Guarant'd %	Found %	Found %	Found %
12.43	11.44	11.38	8.87	47.42	53.55	10.76	9.37	9.64	8.37	
12.69	11.44	12.00	8.87	37.30	53.55	12.16	9.37	13.94	11.91	
12.00	11.44	10.55	8.87	45.37	53.55	10.42	9.37	12.94	8.72	
12.69	11.44	9.97	8.87	48.65	53.55	10.81	9.37	10.97	6.91	
12.69	11.44	10.47	8.87	47.14	53.55	12.29	9.37	9.75	7.66	
12.31	11.44	7.72	8.87	51.51	53.55	9.68	9.37	10.25	8.53	
12.00	11.44	11.64	8.87	45.34	53.55	12.03	9.37	9.01	9.98	
12.40	11.44	10.53	8.87	46.11	53.55	11.16	9.37	10.93	8.87	3.86
9.56	9.00	8.85	8.35	40.49	44.00	19.22	18.00	9.41	12.47	
9.87	9.00	5.82	8.35	47.25	44.00	14.57	18.00	11.35	11.14	
9.72	9.00	7.33	8.35	43.87	44.00	16.90	18.00	10.38	11.80	22.98
12.43	9.69	10.21	9.90	56.42	45.59	6.24	13.67	9.80	4.90	None
10.75	9.62	7.95	8.75	49.62	53.88	12.43	9.25	10.49	8.76	8.09
14.95	14.25	15.68	13.53	40.25	42.92	11.12	9.26	9.67	8.33	
12.25	14.25	12.24	13.53	40.90	42.92	10.55	9.26	11.60	12.46	
13.81	14.25	13.25	13.53	42.60	42.92	10.83	9.26	8.41	11.10	
13.67	14.25	13.73	13.53	41.25	42.92	10.83	9.26	9.89	10.63	2.76
13.06	12.06	8.67	10.90	49.71	51.59	9.65	6.55	10.40	8.51	
13.19	12.06	11.97	10.90	47.23	51.59	7.93	6.55	12.20	7.48	
12.88	12.06	10.99	10.90	46.67	51.59	8.65	6.55	11.38	9.43	
13.04	12.06	10.54	10.90	47.88	51.59	8.74	6.55	11.33	8.47	None

RICE

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
National Rice Milling Co., New Orleans, La.		
Rice Bran	3304	1
	3528	1
	3654	1
	3878	2
	3933	3
	4046	1
	4136	4
	4305	4
Average		17
Rice Bran	2524	1
	2940	1
	3144	1
	3259	1
	3363	2
	3747	1
	4406	2
	4551	1
	4731	1
	4839	2
Average		13
New Iberia Rice Mill, New Iberia, La.		
Rice Bran	2277	2
	2376	1
Average		3
Northern Rice Milling Co., Jennings, La.		
Rice Bran	2315	1
	2327	1
	3481	1
Average		3
Orleans Rice Milling Co., New Orleans, La.		
Rice Bran	2239	5
	2366	2
	2478	2

BRANS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		Water	Ash	Hulls
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %	Found %
13.50	12.13	11.24	13.17	46.64	46.96	8.91	8.45	10.76	8.95	
13.13	12.13	12.13	13.17	45.49	46.96	8.86	8.45	11.83	8.56	
12.94	12.13	10.88	13.17	48.88	46.96	9.17	8.45	9.36	8.77	
13.25	12.13	11.27	13.17	47.72	46.96	9.04	8.45	9.65	9.07	
13.63	12.13	10.40	13.17	49.14	46.96	8.86	8.45	9.68	8.29	
13.50	12.13	10.62	13.17	47.45	46.96	8.19	8.45	12.06	8.18	
13.31	12.13	10.90	13.17	48.97	46.96	8.27	8.45	10.74	7.81	
13.50	12.13	10.81	13.17	49.75	46.96	8.67	8.45	9.46	7.81	
13.35	12.13	11.03	13.17	48.01	46.96	8.74	8.45	10.44	8.43	None
12.31	11.25	11.14	12.95	46.28	42.58	10.82	10.97	11.17	8.28	
12.19	11.25	9.81	12.95	47.27	42.58	9.79	10.97	13.11	7.83	
11.69	11.25	10.26	12.95	42.46	42.58	12.35	10.97	12.88	10.36	
11.88	11.25	8.15	12.95	48.89	42.58	10.45	10.97	12.94	7.69	
12.43	11.25	11.19	12.95	43.47	42.58	13.54	10.97	9.16	10.21	
11.38	11.25	7.14	12.95	51.14	42.58	10.30	10.97	10.53	9.51	
11.81	11.25	8.30	12.95	49.67	42.58	11.30	10.97	9.63	9.29	
11.25	11.25	8.18	12.95	51.43	42.58	11.04	10.97	9.64	8.46	
12.31	11.25	11.34	12.95	44.61	42.58	11.86	10.97	10.36	9.52	
11.94	11.25	10.62	12.95	49.41	42.58	10.87	10.97	9.39	7.77	
11.92	11.25	9.61	12.95	47.47	42.58	11.23	10.97	10.88	8.89	4.10
12.81	13.63	11.01	16.87	50.05	43.46	7.85	6.62	10.33	7.95	
14.25	13.63	14.35	16.87	47.01	43.46	6.34	6.62	10.46	7.59	
13.53	13.63	12.68	16.87	48.53	43.46	7.10	6.62	10.39	7.77	None
12.75	8.00	11.34	10.00	43.53	40.00	12.48	20.00	10.99	8.91	
10.25	8.00	8.13	10.00	48.69	40.00	13.45	20.00	10.37	9.11	
14.25	8.00	14.04	10.00	40.54	40.00	11.47	20.00	12.12	7.58	
12.42	8.00	11.17	10.00	44.25	40.00	12.47	20.00	11.16	8.53	8.23
10.75	7.38	7.66	6.87	47.07	43.80	14.20	18.55	9.36	10.99	
8.69	7.38	5.69	6.87	42.43	43.80	20.30	18.55	9.28	13.61	
7.13	7.38	4.40	6.87	36.39	43.80	25.84	18.55	1 .22	16.02	

RICE

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Orleans Rice Milling Co.—Continued.		
	2655	1
	3213	2
	3278	2
	3529	1
	4015	1
Average		16
People's Independent Rice Mill Co., Crowley, La.		
Rice Bran	2311	1
	2688	1
	2849	1
	3010	1
	4143	1
Average		5
Planter Rice Mill Co., Ltd., Abbeville, La.		
Rice Bran	2235	2
	2531	3
	2613	2
	2943	1
	3174	1
	3255	1
	3406	1
	3673	1
	3764	1
	4218	1
	4400	1
Average		15
Rayne Rice Mill Co., Ltd., Rayne, La.		
Rice Bran	2308	7
	2414	3
	2541	3
	2629	2
	2738	2
	2852	1
	3001	2

BRANS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		Water	Ash	Hulls
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %	Found %
7.13	7.38	4.05	6.87	41.58	43.80	22.28	18.55	9.85	15.11	
8.25	7.38	5.74	6.87	38.15	43.80	24.23	18.55	9.49	14.14	
7.13	7.38	4.14	6.87	37.01	43.80	27.22	18.55	8.67	15.83	
6.56	7.38	3.46	6.87	38.07	43.80	26.87	18.55	9.83	15.21	
8.69	7.38	5.68	6.87	38.23	43.80	24.75	18.55	8.68	13.97	
8.04	7.38	5.10	6.87	39.87	43.80	23.21	18.55	9.42	14.36	43.99
12.50	11.06	10.85	13.00	50.61	38.00	9.14	13.18	10.49	6.41	
13.00	11.06	13.67	13.00	42.42	38.00	11.57	13.18	11.23	8.11	
13.00	11.06	13.99	13.00	39.69	38.00	12.65	13.18	11.90	8.77	
12.75	11.06	9.75	13.00	49.87	38.00	9.29	13.18	10.29	8.05	
13.56	11.06	13.76	13.00	42.99	38.00	11.74	13.18	9.70	8.25	
12.96	11.06	12.40	13.00	45.12	38.00	10.88	13.18	10.72	7.92	2.93
13.25	10.00	11.46	11.00	48.90	42.00	9.24	15.00	9.51	7.64	
12.37	10.00	10.83	11.00	51.23	42.00	8.30	15.00	9.08	8.19	
12.94	10.00	11.35	11.00	45.58	42.00	10.41	15.00	10.11	9.61	
13.75	10.00	12.89	11.00	44.74	42.00	8.68	15.00	11.92	8.02	
13.50	10.00	11.34	11.00	45.54	42.00	8.86	15.00	12.79	7.97	
13.06	10.00	9.83	11.00	48.32	42.00	7.94	15.00	12.81	8.04	
12.06	10.00	9.15	11.00	47.79	42.00	9.94	15.00	12.25	8.81	
12.81	10.00	9.76	11.00	50.73	42.00	8.64	15.00	9.99	8.07	
13.75	10.00	13.71	11.00	42.32	42.00	10.42	15.00	9.63	10.17	
13.38	10.00	11.93	11.00	47.92	42.00	8.02	15.00	11.23	7.52	
13.13	10.00	11.10	11.00	48.77	42.00	8.81	15.00	9.92	8.27	
13.09	10.00	11.21	11.00	47.45	42.00	9.02	15.00	10.84	8.39	None
6.50	7.00	3.77	4.50	40.92	37.25	24.77	27.25	9.19	14.85	
7.25	7.00	3.88	4.50	40.11	37.25	25.00	27.25	9.00	14.76	
6.81	7.00	4.51	4.50	37.60	37.25	26.60	27.25	9.89	14.59	
7.31	7.00	4.22	4.50	40.49	37.25	24.08	27.25	9.41	14.49	
7.13	7.00	4.62	4.50	36.62	37.25	25.64	27.25	10.27	15.72	
7.00	7.00	3.87	4.50	38.45	37.25	25.09	27.25	10.73	14.86	
7.30	7.00	4.62	4.50	37.71	37.25	25.24	27.25	10.45	14.68	

RICE

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Rayne Rice Mill Co.—Continued.		
	3212	4
	3319	1
	5383	1
Average		26
A. Sacola, New Orleans, La.		
Rice Bran, "A. S."	2221	11
	2356	1
	2559	2
	2686	1
	2746	1
	2882	3
	2992	1
	3073	2
	3175	1
	3405	1
	3527	1
	3638	1
	3857	1
	4978	1
	5125	1
	5284	1
	5359	1
Average		31
A. Sacola, New Orleans, La.		
Rice Bran, "M"	2216	2
	2343	2
	2588	1
	2685	1
	2910	2
	3077	2
	3639	1
Average		11
Southern Rice Milling Co., New Orlears, La.		
Rice Bran	3130	1
	3991	1
	5358	1
Average		3

BRANS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		Water	Ash	Hulls
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %	Found %
6.81	7.00	3.84	4.50	38.12	37.25	26.52	27.25	9.82	14.89	
6.50	7.00	4.08	4.50	37.25	37.25	27.01	27.25	9.27	15.89	
5.06	7.00	3.18	4.50	38.45	37.25	28.70	27.25	8.74	15.87	
6.77	7.00	4.06	4.50	38.57	37.25	25.86	27.25	9.68	15.06	52.81
11.94	11.37	11.51	12.50	45.79	42.27	10.95	14.40	9.34	10.47	
12.43	11.37	12.66	12.50	39.38	42.27	14.37	14.40	10.43	10.73	
12.19	11.37	9.79	12.50	48.71	42.27	10.87	14.40	9.90	8.54	
11.94	11.37	10.44	12.50	44.49	42.27	12.09	14.40	10.97	10.07	
13.69	11.37	13.74	12.50	38.60	42.27	14.15	14.40	10 31	9.51	
12.75	11.37	11.49	12.50	43.46	42.27	13.09	14.40	9.18	10.03	
11.88	11.37	9.76	12.50	47.96	42.27	8.18	14.40	12.73	9.49	
12.44	11.37	10.49	12.50	42.23	42.27	12.05	14.40	12.70	10.09	
11.81	11.37	9.74	12.50	44.57	42.27	12.01	14.40	12.53	9.34	
12.81	11.37	10.57	12.50	43.76	42.27	12.34	14.40	10.93	9.59	
11.25	11.37	7.66	12.50	47.50	42.27	12.31	14.40	11.74	9.54	
12.88	11.37	10.98	12.50	43.75	42.27	11.66	14.40	8.40	12.33	
11.56	11.37	9.15	12.50	47.19	42.27	13.55	14.40	8.35	10.20	
10.69	11.37	10.60	12.50	37.49	42.27	18.22	14.40	8.45	14.55	
11.38	11.37	11.03	12.50	47.34	42.27	9.81	14.40	11.76	8.68	
11.19	11.37	10.40	12.50	51.15	42.27	9.84	14.40	7.26	10.16	
10.88	11.37	9.55	12.50	41.46	42.27	14.55	14.40	10.37	13.19	
11.98	11.37	10.56	12.50	44.41	42.27	12.36	14.40	10.31	10.38	7.86
7.56	6.06	5.42	5.75	39.26	33.09	23.20	29.12	9.27	15.29	
8.06	6.06	5.77	5.75	38.54	33.09	23.19	29.12	9.96	14.48	
10.95	6.06	9.36	5.75	40.68	33.09	18.11	29.12	10.59	10.31	
7.45	6.06	6.02	5.75	32.22	33.09	27.78	29.12	12.46	14.07	
8.69	6.06	7.60	5.75	36.89	33.09	22.52	29.12	9.76	14.54	
8.63	6.06	7.05	5.75	37.93	33.09	21.73	29.12	10.44	14.22	
9.44	6.06	6.76	5.75	40.19	33.09	20.51	29.12	9.62	13.48	
8.68	6.06	6.86	5.75	37.96	33.09	22.43	29.12	10.30	13.77	41.39
9.81	10.50	7.80	9.50	39.68	44.75	17.35	15.75	12.85	12.51	
10.50	10.50	8.78	9.50	41.35	44.75	18.16	15.75	9.03	12.18	
12.00	10.50	9.71	9.50	41.43	44.75	11.03	15.75	14.22	11.61	
10.77	10.50	8.76	9.50	40.83	44.75	15.51	15.75	12.03	12.10	18.35

298042

RICE

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Star Rice Milling Co., Crowley, La.		
Rice Bran	2309	1
	2721	1
	3209	1
	3856	1
	4745	1
Average		5
United States Rice Milling Co., Crowley, La.		
Rice Bran	2217	4
	2420	1
	2667	1
	2779	1
	2856	1
	2933	1
	3029	1
	3146	1
	3208	1
	3346	2
	3640	1
	5405	1
Average		16
Wall Rice Milling Co., Lake Charles, La.		
Rice Bran, "No. 1"	2355	1
	2594	1
	3069	2
	3303	1
	3746	1
	3855	1
Average		7
White Swan Rice Mill Co., Morse, La.		
Rice Bran	2299	1
	4373	1
Average		2

BRANS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		Water	Ash	Hulls
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %	Found %
10.88	8.00	7.57	10.00	48.43	40.00	12.56	20.00	11.34	9.22	
11.69	8.00	10.25	10.00	43.37	40.00	12.08	20.00	13.61	9.00	
12.00	8.00	10.54	10.00	44.76	40.00	10.95	20.00	12.60	9.15	
11.44	8.00	10.10	10.00	45.74	40.00	13.67	20.00	9.42	9.63	
13.06	8.00	10.06	10.00	45.07	40.00	13.00	20.00	9.57	9.24	
11.81	8.00	9.70	10.00	45.48	40.00	12.45	20.00	11.31	9.25	8.16
12.43	9.69	10.90	9.90	50.29	45.59	8.76	13.67	10.07	7.55	
13.31	9.69	13.47	9.90	41.47	45.59	10.44	13.67	12.48	8.83	
13.88	9.69	12.87	9.90	41.92	45.59	11.93	13.67	10.66	8.74	
13.69	9.69	14.29	9.90	39.93	45.59	11.34	13.67	11.49	9.26	
13.38	9.69	12.49	9.90	44.34	45.59	9.94	13.67	11.63	8.22	
12.31	9.69	12.67	9.90	42.74	45.59	10.97	13.67	10.97	10.34	
12.06	9.69	9.70	9.90	47.95	45.59	8.56	13.67	12.73	9.00	
12.00	9.69	12.10	9.90	45.64	45.59	8.60	13.67	11.87	9.79	
13.06	9.69	13.74	9.90	38.52	45.59	11.93	13.67	12.79	9.96	
13.06	9.69	12.30	9.90	45.10	45.59	10.25	13.67	10.18	9.11	
14.50	9.69	14.57	9.90	41.76	45.59	10.33	13.67	10.70	8.14	
10.94	9.69	9.07	9.90	52.08	45.59	7.57	13.67	12.62	7.72	
12.89	9.69	12.35	9.90	44.31	45.59	10.05	13.67	11.52	8.88	0.17
14.93	10.06	12.59	9.20	41.03	44.87	14.57	15.00	9.82	7.06	
13.50	10.06	13.29	9.20	48.81	44.87	6.73	15.00	9.16	8.51	
12.19	10.06	11.06	9.20	40.54	44.87	15.17	15.00	11.21	9.83	
11.75	10.06	11.02	9.20	43.63	44.87	14.01	15.00	9.73	9.86	
12.19	10.06	11.43	9.20	42.23	44.87	13.54	15.00	10.53	10.08	
11.50	10.06	10.04	9.20	42.59	44.87	15.69	15.00	10.04	10.14	
12.68	10.06	11.57	9.20	43.14	44.87	13.28	15.00	10.08	9.25	10.92
11.56	8.00	10.46	10.00	46.22	40.00	12.38	20.00	10.26	9.12	
10.88	8.00	9.15	10.00	50.05	40.00	11.26	20.00	9.56	9.10	
11.22	8.00	9.81	10.00	48.13	40.00	11.82	20.00	9.91	9.11	6.06

RICE

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Abbeville Rice Mill Co., Abbeville, La.		
Rice Polish	2326	1
	3473	1
Average		2
American Rice Milling Co., Crowley, La.		
Rice Polish	2241	3
	2532	3
	2636	2
	2719	1
	3016	1
	3143	1
	2378	1
Average		12
Conover Rice Milling Co., Mermenteau, La.		
Rice Polish	2336	1
	2904	1
	3597	1
Average		3
Crowley Rice Milling Co., Crowley, La.		
Rice Polish	2245	2
	2407	1
	2545	1
	2770	1
	2938	1
	3359	1
	3641	1
	4906	1
Average		9
Donaldsonville Rice Mill, Donaldsonville, La.		
Rice Polish	2279	2

POLISHES.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
10.88	0.10	5.85	0.06	66.11	65.00	2.29	0.10	11.01	3.86
12.13	0.10	7.07	0.06	63.71	65.00	2.18	0.10	11.02	3.89
—	—	—	—	—	—	—	—	—	—
11.50	0.10	6.46	0.06	64.91	65.00	2.24	0.10	11.02	3.87
10.69	9.56	5.35	5.90	66.92	66.12	2.64	2.95	10.96	3.44
10.56	9.56	5.50	5.90	68.57	66.12	1.77	2.95	10.22	3.38
12.25	9.56	7.95	5.90	63.75	66.12	1.86	2.95	10.32	3.87
12.25	9.56	4.79	5.90	67.13	66.12	1.40	2.95	11.57	2.86
11.44	9.56	6.59	5.90	64.30	66.12	1.86	2.95	12.22	3.59
12.00	9.56	7.34	5.90	62.93	66.12	2.04	2.95	11.80	3.89
11.06	9.56	8.58	5.90	63.30	66.12	1.75	2.95	11.25	4.06
—	—	—	—	—	—	—	—	—	—
11.46	9.56	6.59	5.90	65.28	66.12	1.90	2.95	11.19	3.58
11.63	9.00	5.47	5.00	66.74	50.00	1.22	3.00	12.03	2.91
10.56	9.00	6.38	5.00	69.18	50.00	1.03	3.00	9.89	2.96
10.75	9.00	5.13	5.00	69.66	50.00	0.74	3.00	10.69	3.03
—	—	—	—	—	—	—	—	—	—
10.98	9.00	5.66	5.00	68.52	50.00	1.01	3.00	10.87	2.96
10.69	10.50	6.85	8.75	63.64	65.75	3.48	2.25	10.68	4.66
10.25	10.50	5.79	8.75	67.65	65.75	2.38	2.25	10.84	3.09
10.56	10.50	6.00	8.75	68.01	65.75	1.65	2.25	10.46	3.32
12.06	10.50	7.07	8.75	62.31	65.75	2.86	2.25	11.11	4.59
12.00	10.50	6.52	8.75	62.79	65.75	3.77	2.25	10.51	4.41
11.50	10.50	8.37	8.75	63.25	65.75	2.68	2.25	9.84	4.36
11.94	10.50	7.65	8.75	61.20	65.75	3.07	2.25	10.82	5.32
12.25	10.50	5.97	8.75	64.20	65.75	3.26	2.25	9.70	4.62
—	—	—	—	—	—	—	—	—	—
11.41	10.50	6.78	8.75	64.13	65.75	2.89	2.25	10.49	4.30
10.75	13.88	6.92	4.20	61.09	62.75	3.59	4.73	11.80	5.85

RICE

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Empire Rice Milling Co., New Orleans, La.		
Rice Polish	2707	1
Eureka Rice Milling Co., Esterwood, La.		
Rice Polish	2312	1
	2598	1
Average		2
Gueydan Rice Milling Co., Ltd., Gueydan, La.		
Rice Polish	3014	1
	2375	1
Average		2
Gulf Rice Milling Co., Welsh, La.		
Rice Polish	2229	2
	2491	1
	3012	1
	3142	1
Average		5
Haspel and Davis, New Orleans, La.		
Rice Polish	2421	1
	2626	1
	2816	1
	3087	1
Average		4
Ida Rice Mill, Rayne, La.		
Rice Polish	2236	2
	2494	1
Average		3

POLISHES.

PROTEIN		FAT		CARBOHY-DRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
11.13	10.50	6.43	7.50	66.06	65.42	0.88	1.25	11.49	4.01
11.38	12.75	6.74	10.67	64.77	61.05	1.88	1.87	11.77	3.46
11.79	12.75	9.44	10.67	62.01	61.05	1.57	1.87	10.74	4.45
11.58	12.75	8.09	10.67	63.39	61.05	1.73	1.87	11.26	3.95
11.75	0.60	7.63	0.06	62.38	65.00	2.45	0.10	12.03	3.76
10.69	0.60	5.26	0.06	68.82	65.00	1.62	0.10	10.95	2.66
11.22	0.60	6.44	0.06	65.60	65.00	2.04	0.10	11.49	3.21
12.88	12.00	10.47	6.00	58.58	67.00	3.50	1.00	9.83	4.74
13.00	12.00	11.46	6.00	58.18	67.00	2.47	1.00	10.28	4.61
12.50	12.00	10.70	6.00	57.65	67.00	2.63	1.00	11.46	5.06
11.19	12.00	6.47	6.00	65.34	67.00	1.61	1.00	11.53	3.86
12.39	12.00	9.78	6.00	59.94	67.00	2.55	1.00	10.77	4.57
10.75	11.37	7.43	6.25	66.81	65.88	1.47	1.25	9.53	4.01
11.00	11.37	6.91	6.25	64.74	65.88	2.43	1.25	10.51	4.41
11.50	11.37	5.75	6.25	68.74	65.88	1.16	1.25	9.97	2.88
10.81	11.37	6.08	6.25	66.22	65.88	2.19	1.25	10.84	3.86
11.01	11.37	6.54	6.25	66.64	65.88	1.81	1.25	10.21	3.79
11.81	11.37	7.06	5.75	64.56	67.22	2.26	0.50	10.30	4.01
10.44	11.37	5.43	5.75	67.90	67.22	1.77	0.50	11.09	3.37
11.13	11.37	6.24	5.75	66.23	67.22	2.02	0.50	10.69	3.69

RICE

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Iota Rice Milling Co., Iota, La.		
Rice Polish	2306	2
	2854	1
	3141	1
Average		4
Jennings Rice Mill Co., Jennings, La.		
Rice Polish	2246	2
	2848	1
	3135	1
	4256	1
Average		5
Jennings Rice Mill Co., Welsh, La.		
Rice Polish	2319	1
	2489	1
	2648	1
	3013	1
	3356	1
	3992	1
Average		6
Jones Bros., Crowley, La.		
Rice Polish	2331	1
	3357	1
Average		2
Lake Arthur Rice Milling Co., Lake Arthur, La.		
Rice Polish	2329	1
	2495	1
	3445	1
	3805	1
Average		4

POLISHES.

PROTEIN		FAT		CARBOHY-DRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
11.31	10.00	6.63	6.00	65.72	65.00	1.99	1.00	11.14	3.21
11.56	10.00	6.11	6.00	66.65	65.00	1.25	1.00	11.62	2.81
12.00	10.00	6.37	6.00	65.13	65.00	1.59	1.00	11.59	3.32
11.62	10.00	6.37	6.00	65.84	65.00	1.61	1.00	11.45	3.11
10.38	10.00	4.78	6.00	70.57	65.00	1.20	1.00	11.07	2.00
11.88	10.00	5.60	6.00	67.78	65.00	1.17	1.00	10.91	2.66
11.56	10.00	6.32	6.00	67.05	65.00	1.22	1.00	11.42	2.43
10.56	10.00	4.88	6.00	72.57	65.00	0.99	1.00	8.96	2.04
11.10	10.00	5.40	6.00	69.49	65.00	1.14	1.00	10.59	2.28
11.31	10.00	8.85	6.00	62.56	65.00	2.38	1.00	11.07	3.83
11.75	10.00	8.02	6.00	63.86	65.00	2.30	1.00	10.30	3.77
11.75	10.00	9.32	6.00	61.38	65.00	2.84	1.00	10.51	4.20
11.56	10.00	8.55	6.00	62.50	65.00	2.34	1.00	11.26	3.79
14.25	10.00	11.18	6.00	56.03	65.00	3.66	1.00	10.02	4.86
12.06	10.00	7.33	6.00	63.66	65.00	2.58	1.00	9.90	4.47
12.11	10.00	8.88	6.00	61.67	65.00	2.68	1.00	10.51	4.15
11.31	10.00	5.89	0.06	65.66	65.00	2.53	0.01	10.73	3.88
11.06	10.00	4.32	0.06	71.66	65.00	0.88	0.01	10.30	1.78
11.18	10.00	5.11	0.06	68.66	65.00	1.71	0.01	10.51	2.83
11.81	9.00	7.23	5.00	65.37	50.00	1.77	3.00	10.41	3.41
11.50	9.00	8.07	5.00	62.88	50.00	1.81	3.00	10.22	5.52
11.00	9.00	7.50	5.00	65.85	50.00	1.38	3.00	10.65	3.62
11.13	9.00	7.93	5.00	64.34	50.00	1.75	3.00	10.54	4.31
11.36	9.00	7.68	5.00	64.62	50.00	1.68	3.00	10.45	4.21

RICE

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Lake Charles Rice Milling Co., Lake Charles, La.		
Rice Polish	2322	2
	2550	1
	3085	1
	3474	1
	3910	1
Average		6
Leona Rice Milling Co., New Orleans, La.		
Rice Polish	3301	1
Levy Rice Milling Co., New Orleans, La.		
Rice Polish	3459	1
Midland Rice Mill, Midland, La.		
Rice Polish	2310	1
Morse Rice Milling Co., Ltd., Morse, La.		
Rice Polish	2328	1
Mutual Rice Mill Co., Gueydan, La.		
Rice Polish	2593	1
	3011	1
Average		2
National Rice Milling Co., Crowley, La.		
Rice Polish	2335	1
	2781	1
	3358	1
Average		3
National Rice Milling Co., New Orleans, La.		
Rice Polish	2820	1
Polish	4543	1
	4734	1
	4909	2
	5205	1
	5281	1
Average		6

POLISHES.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
11.56	12.00	7.82	10.00	65.78	60.00	1.87	3.00	9.75	3.22
12.13	12.00	8.80	10.00	63.50	60.00	1.96	3.00	9.74	3.87
11.19	12.00	6.58	10.00	65.92	60.00	1.52	3.00	11.17	3.62
10.75	12.00	7.06	10.00	66.83	60.00	1.08	3.00	10.60	3.68
12.00	12.00	3.94	10.00	69.43	60.00	1.15	3.00	10.16	3.32
11.53	12.00	6.84	10.00	66.29	60.00	1.52	3.00	10.28	3.54
11.29	10.13	7.68	4.77	64.03	69.28	1.93	2.20	10.73	4.34
12.88	11.01	7.23	8.37	64.44	63.41	0.82	1.07	10.39	4.24
11.75	11.25	8.33	11.22	63.33	61.54	1.53	2.77	11.10	3.96
10.81	9.62	5.62	8.75	67.42	60.97	2.09	4.50	11.35	2.71
14.46	12.56	11.52	5.88	56.28	65.01	2.41	1.41	10.50	4.83
13.69	12.56	11.35	5.88	55.80	65.01	2.48	1.41	11.14	5.54
14.08	12.56	11.43	5.88	56.04	65.01	2.44	1.41	10.82	5.19
12.63	11.06	11.38	9.07	57.58	62.12	3.50	2.25	10.41	4.50
12.50	11.06	7.35	9.07	61.66	62.12	2.43	2.25	12.84	3.22
11.69	11.06	6.14	9.07	65.89	62.12	1.85	2.25	11.37	3.06
12.27	11.06	8.29	9.07	61.71	62.12	2.59	2.25	11.54	3.59
12.50	11.31	10.64	12.20	60.41	59.07	2.09	1.32	10.00	4.36
12.88	10.56	8.45	10.17	63.65	62.40	1.10	1.20	8.80	5.12
10.56	10.56	7.37	10.17	69.45	62.40	0.99	1.20	8.38	3.27
13.00	10.56	9.42	10.17	62.54	62.40	1.42	1.20	8.74	4.88
12.38	10.56	9.35	10.17	62.44	62.40	1.56	1.20	8.33	5.94
11.00	10.56	8.48	10.17	66.18	62.40	0.88	1.20	8.45	5.01
11.96	10.56	8.61	10.17	64.85	62.40	1.19	1.20	8.54	4.85

RICE

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
New Iberia Rice Mill, New Iberia, La.		
Rice Polish	2269	2
	2382	1
Average		3
Northern Rice Milling Co., Jennings, La.		
Rice Polish	2275	2
	3475	1
Average		3
Orleans Rice Milling Co., New Orleans, La.		
Rice Polish	2288	2
People's Independent Rice Mill Co., Crowley, La.		
Rice Polish	4121	1
Planters' Rice Milling Co., Abbeville, La.		
Rice Polish	2244	2
	2542	2
	2935	1
	3386	1
	4212	1
	4407	2
Average		9
Rayne Rice Milling Co., Rayne, La.		
Rice Polish	2307	2
	2419	1
Average		3
A. Socola, New Orleans, La.		
Rice Polish, "A. S."	2203	6
	2341	2
	2567	2
	2709	2

POLISHES.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
11.44	10.19	9.60	9.22	59.46	62.97	2.11	1.25	11.95	5.44
12.06	10.19	10.60	9.22	56.10	62.97	2.75	1.25	12.10	6.39
———	———	———	———	———	———	———	———	———	———
11.75	10.19	10.10	9.22	57.78	62.97	2.43	1.25	12.03	5.91
10.50	11.44	5.87	6.92	67.83	66.70	1.41	5.00	11.50	2.89
11.94	11.44	5.59	6.92	66.69	66.70	1.98	5.00	10.62	3.18
———	———	———	———	———	———	———	———	———	———
11.22	11.44	5.73	6.92	67.26	66.70	1.70	5.00	11.06	3.03
10.69	10.50	7.62	7.00	66.81	68.09	1.39	0.50	10.10	3.39
12.00	12.75	6.87	10.67	65.90	61.05	1.36	1.87	10.20	3.67
12.69	15.08	10.20	8.34	58.16	56.23	3.00	3.00	10.33	5.62
12.45	15.08	9.40	8.34	61.01	56.23	2.02	3.00	10.51	4.61
12.81	15.08	11.19	8.34	55.77	56.23	3.15	3.00	11.32	5.76
13.94	15.08	11.25	8.34	54.51	56.23	3.33	3.00	10.41	6.56
14.50	15.08	11.18	8.34	55.55	56.23	3.15	3.00	10.53	5.09
13.56	15.08	10.36	8.34	57.89	56.23	2.95	3.00	9.40	5.84
———	———	———	———	———	———	———	———	———	———
13.32	15.08	10.60	8.34	57.15	56.23	2.93	3.00	10.42	5.58
11.06	10.00	5.19	6.00	62.72	65.00	4.88	1.00	11.30	4.85
10.44	10.00	5.93	6.00	67.78	65.00	1.52	1.00	10.77	3.56
———	———	———	———	———	———	———	———	———	———
10.75	10.00	5.56	6.00	65.25	65.00	3.20	1.00	11.04	4.20
10.44	9.44	6.92	7.73	66.60	67.68	1.67	0.83	10.48	3.89
11.25	9.44	7.08	7.73	66.61	67.68	1.73	0.83	10.16	3.17
12.50	9.44	8.42	7.73	62.65	67.68	2.13	0.83	10.18	4.12
12.05	9.44	7.42	7.73	64.60	67.68	1.42	0.83	10.78	3.73

RICE

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
A. Socola—Continued.		
	2821	1
	2898	1
	2991	1
	3086	1
	3204	1
	3686	1
	4981	1
	5123	1
	5286	1
	5372	1
Average		22
Star Rice Milling Co., Crowley, La.		
Rice Polish	2313	1
	2717	1
	3203	1
	3851	1
	4741	1
Average		5
United States Rice Mill Co., Ltd., Crowley, La.		
Rice Polish..	2224	3
	3015	1
	3407	1
Average..		5
Wall Rice Milling Co., Lake Charles, La.		
Rice Polish	2231	3
	2596	1
	3074	2
	3835	2
	4213	1
Average		9

POLISHES.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
12.83	9.44	8.23	7.73	62.60	67.68	1.53	0.83	10.18	4.63
11.00	9.44	6.01	7.73	68.53	67.68	1.39	0.83	10.56	2.51
13.94	9.44	11.68	7.73	57.25	67.68	2.59	0.83	10.42	4.12
12.00	9.44	8.30	7.73	62.59	67.68	2.24	0.83	10.95	3.92
10.69	9.44	4.84	7.73	68.66	67.68	1.55	0.83	11.47	2.79
13.38	9.44	7.65	7.73	64.62	67.68	1.83	0.83	9.29	3.23
11.81	9.44	6.18	7.73	67.22	67.68	2.55	0.83	8.42	3.82
10.28	9.44	6.12	7.73	67.97	67.68	1.39	0.83	9.85	4.39
10.25	9.44	6.73	7.73	67.83	67.68	1.80	0.83	8.50	4.89
11.19	9.44	8.87	7.73	62.41	67.68	2.15	0.83	9.16	6.22
11.69	9.44	7.46	7.73	65.01	67.68	1.85	0.83	10.03	3.96
10.31	12.00	5.44	6.00	68.45	65.00	1.24	1.00	11.46	3.10
12.28	12.00	8.35	6.00	2.39	65.00	1.43	1.00	11.71	3.84
12.06	12.00	7.05	6.00	63.84	65.00	1.39	1.00	11.61	4.05
12.00	12.00	7.26	6.00	65.25	65.00	1.24	1.00	10.15	4.10
12.75	12.00	8.65	6.00	64.26	65.00	1.47	1.00	9.28	3.59
11.88	12.00	7.35	6.00	64.84	65.00	1.35	1.00	10.84	3.74
11.56	11.25	7.94	11.22	63.47	61.54	1.94	2.77	10.80	4.29
10.75	11.25	7.27	11.22	64.65	61.54	1.77	2.77	11.48	4.08
12.13	11.25	9.90	11.22	58.92	61.54	2.68	2.77	10.67	5.70
11.48	11.25	8.37	11.22	62.35	61.54	2.13	2.77	10.98	4.69
11.69	14.30	7.99	12.00	65.13	57.95	1.95	2.05	10.36	2.88
11.38	14.30	6.89	12.00	65.75	57.95	1.92	2.05	10.78	3.28
12.31	14.30	9.34	12.00	60.66	57.95	2.26	2.05	11.18	4.25
11.63	14.30	7.74	12.00	64.56	57.95	1.99	2.05	10.19	3.89
11.44	14.30	7.52	12.00	65.57	57.95	1.11	2.05	10.68	3.68
11.69	14.30	7.90	12.00	64.33	57.95	1.85	2.05	10.64	3.59

RICE

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
White Swan Rice Milling Co., Morse, La.		
Rice Polish	2317	1
	4370	1
Average		2

WHEAT

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Anchor Roller Mills, Fort Worth, Tex.		
Pure Wheat Bran	3692	1
	5317	2
Average		3
Atchison Live Stock Co., Atchison, Kan.		
Wheat Bran	2344	3
	2469	2
	2642	1
	2714	2
	2957	2
	3043	1
	3078	2
	3131	1
	3250	3
	3342	4
	3470	3
	3559	2
	3647	2
	3744	1
	3812	3
	3931	2
	4128	1
Average		35
C. Becker Milling Co., Red Bud, Ill.		
Wheat Bran	2230	4
	2263	4
	2416	5
	2585	1
	2690	2

POLISHES.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
11.00	12.00	6.17	6.00	64.47	65.00	3.01	1.00	11.38	3.97
11.75	12.00	7.77	6.00	64.36	65.00	2.53	1.00	9.34	4.25
11.38	12.00	6.97	6.00	64.41	65.00	2.77	1.00	10.36	4.11

BRANS.

PROTEIN Found %	PROTEIN Guarant'd %	FAT Found %	FAT Guarant'd %	CARBOHYDRATES Found %	CARBOHYDRATES Guarant'd %	FIBER Found %	FIBER Guarant'd %	WATER Found %	ASH Found %
15.31	18.50	3.91	3.70	58.64	56.00	6.29	7.90	11.35	4.50
17.63	18.50	4.51	3.70	56.41	56.00	6.76	7.90	10.01	4.63
16.47	18.50	4.21	3.70	57.52	56.00	6.53	7.90	10.68	4.59

PROTEIN Found %	PROTEIN Guarant'd %	FAT Found %	FAT Guarant'd %	CARBOHYDRATES Found %	CARBOHYDRATES Guarant'd %	FIBER Found %	FIBER Guarant'd %	WATER Found %	ASH Found %
16.25	3.00	3.58	3.00	50.57	50.00	11.18	20.00	11.65	6.77
16.81	3.00	4.29	3.00	52.01	50.00	9.58	20.00	10.74	6.57
16.69	3.00	3.82	3.00	51.41	50.00	10.96	20.00	10.40	6.72
16.38	3.00	4.09	3.00	50.25	50.00	10.82	20.00	11.62	6.84
15.25	3.00	3.44	3.00	52.25	50.00	11.80	20.00	10.03	7.23
14.06	3.00	3.64	3.00	56.50	50.00	10.19	20.00	8.89	6.72
16.69	3.00	3.58	3.00	51.42	50.00	10.15	20.00	11.61	6.55
16.75	3.00	3.85	3.00	48.66	50.00	11.53	20.00	12.35	6.86
14.31	3.00	3.87	3.00	51.80	50.00	11.22	20.00	11.51	7.29
15.88	3.00	3.51	3.00	50.70	50.00	11.85	20.00	10.48	7.58
15.56	3.00	3.46	3.00	49.70	50.00	12.68	20.00	11.03	7.57
16.31	3.00	3.46	3.00	51.74	50.00	10.96	20.00	10.50	7.03
15.63	3.00	2.98	3.00	49.82	50.00	11.98	20.00	12.15	7.44
15.50	3.00	3.37	3.00	50.71	50.00	12.30	20.00	10.42	7.70
15.44	3.00	3.03	3.00	49.05	50.00	12.13	20.00	12.82	7.53
16.25	3.00	3.72	3.00	52.36	50.00	9.89	20.00	11.25	6.53
15.75	3.00	3.99	3.00	50.74	50.00	11.08	20.00	11.46	6.98
15.85	3.00	3.63	3.00	51.17	50.00	11.19	20.00	11.11	7.05

PROTEIN Found %	PROTEIN Guarant'd %	FAT Found %	FAT Guarant'd %	CARBOHYDRATES Found %	CARBOHYDRATES Guarant'd %	FIBER Found %	FIBER Guarant'd %	WATER Found %	ASH Found %
15.06	14.85	4.02	3.58	53.90	54.60	9.73	10.00	10.51	6.78
15.19	14.85	4.03	3.58	53.57	54.60	9.57	10.00	11.13	6.51
15.00	14.85	3.92	3.58	54.89	54.60	9.49	10.00	10.36	6.34
14.56	14.85	3.83	3.58	54.12	54.60	9.66	10.00	11.57	6.26
14.94	14.85	4.07	3.58	53.36	54.60	9.29	10.00	11.60	6.74

WHEAT

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
C. Becker Milling Co.—Continued.		
	3192	1
	4197	1
	4290	1
	4405	3
	4527	2
	5157	1
	5295	1
Average		26
Bernet, Craft and Kauffman Mill Co., St. Louis, Mo.		
Wheat Bran	2497	1
	3199	1
	4950	1
Average		3
Marcus Bernheimer Flour Mills Co., St. Louis, Mo., and Clinton, Mo.		
Banner Bran	2544	1
	2891	1
	3462	1
	3578	2
	3838	2
	3942	1
	4363	1
	4402	2
	4607	2
	4824	1
	3738	3
	5050	1
	5222	1
Average		19
Beshers and Jackson, Clinton, Ky.		
Wheat Bran	3198	1
	3201	1
	5059	1
Average		3

BRANS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
14.75	14.85	3.82	3.58	54.47	54.60	9.42	10.00	11.00	6.54
14.75	14.85	4.12	3.58	54.12	54.60	9.87	10.00	10.62	6.52
15.44	14.85	4.12	3.58	56.20	54.60	9.91	10.00	8.06	6.27
14.06	14.85	4.09	3.58	55.72	54.60	8.47	10.00	10.87	6.79
14.25	14.85	4.09	3.58	52.65	54.60	9.97	10.00	11.96	7.08
14.13	14.85	4.12	3.58	53.85	54.60	9.44	10.00	10.82	7.64
14.19	14.85	4.22	3.58	56.04	54.60	9.65	10.00	9.02	6.88
14.69	14.85	4.04	3.58	54.40	54.60	9.54	10.00	10.63	6.70
14.87	14.30	4.29	3.55	55.28	55.20	9.07	10.20	10.32	6.17
16.63	14.30	4.03	3.55	52.66	55.20	8.72	10.20	11.74	6.22
14.81	14.30	4.39	3.55	53.12	55.20	9.38	10.20	12.06	6.24
15.44	14.30	4.24	3.55	53.69	55.20	9.05	10.20	11.37	6.21
16.18	14.50	3.94	4.00	53.22	50.00	8.80	9.50	12.12	5.74
17.06	14.50	4.42	4.00	52.78	50.00	9.46	9.50	9.86	6.42
16.50	14.50	4.25	4.00	53.87	50.00	8.05	9.50	11.40	5.93
15.38	14.50	4.31	4.00	54.81	50.00	8.80	9.50	10.55	6.15
14.38	14.50	3.68	4.00	54.11	50.00	9.64	9.50	11.53	6.66
14.56	14.50	3.82	4.00	54.47	50.00	8.72	9.50	11.68	6.75
14.31	14.50	3.74	4.00	52.82	50.00	9.73	9.50	12.81	6.59
16.06	14.50	4.26	4.00	54.23	50.00	8.63	9.50	10.61	6.21
15.88	14.50	4.21	4.00	53.07	50.00	9.63	9.50	10.59	6.62
15.69	14.50	3.94	4.00	53.46	50.00	10.46	9.50	9.45	7.00
16.44	14.50	4.10	4.00	53.59	50.00	8.70	9.50	10.68	6.49
14.38	14.50	4.02	4.00	56.22	50.00	9.94	9.50	8.84	6.60
14.38	14.50	3.82	4.00	54.78	50.00	10.45	9.50	9.43	7.14
15.48	14.50	4.04	4.00	53.96	50.00	9.31	9.50	10.73	6.48
15.00	12.00	4.42	3.00	57.69	50.00	6.12	10.00	12.02	4.75
15.19	12.00	4.33	3.00	57.02	50.00	6.71	10.00	11.80	4.95
14.81	12.00	4.28	3.00	59.06	50.00	5.77	10.00	11.47	4.61
15.00	12.00	4.34	3.00	57.93	50.00	6.20	10.00	11.76	4.77

WHEAT

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Blair Milling Co., Atchison, Kan.		
Blair's Bran	2226	2
	2401	10
	2608	4
	2787	2
	2958	2
	3062	1
	3248	4
	3410	1
	3544	3
	3644	2
	3743	1
	3915	1
	4129	1
	4555	1
	4641	1
	4720	2
	4765	1
	4826	1
	5086	1
	5138	1
	5360	1
	5412	1
Average		44
Bomgardner Grain Co., Kansas City, Mo.		
Wheat Bran	3810	2
Bower Stock Mill and Power Co., Lawrence, Kan.		
Pure Wheat Bran	3894	2
Burrus Mill and Elevator Co., Fort Worth, Tex.		
Burrus Wheat Bran	2266	3
	2357	4
	2553	1
	3083	1
	3158	2
	3272	3
	3690	1
	3941	1
	4048	1
	4374	1

BRANS.

PROTEIN		FAT		CARBOHY-DRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
14.50	14.00	3.93	3.50	55.56	54.00	9.10	9.50	10.16	6.75
16.88	14.00	4.17	3.50	52.58	54.00	10.06	9.50	9.55	6.76
16.44	14.00	4.37	3.50	50.86	54.00	10.43	9.50	11.07	6.83
15.88	14.00	3.83	3.50	52.47	54.00	10.10	9.50	10.95	6.77
16.06	14.00	4.04	3.50	52.66	54.00	9.50	9.50	10.20	7.54
15.56	14.00	3.54	3.50	52.96	54.00	10.36	9.50	10.91	6.67
15.63	14.00	3.88	3.50	52.06	54.00	9.86	9.50	11.94	6.63
16.00	14.00	3.85	3.50	52.69	54.00	10.24	9.50	10.69	6.60
16.38	14.00	3.95	3.50	52.79	54.00	9.90	9.50	10.50	6.48
14.93	14.00	4.03	3.50	52.76	54.00	9.58	9.50	11.96	6.74
16.06	14.00	4.02	3.50	52.38	54.00	10.27	9.50	10.41	6.86
15.94	14.00	3.80	3.50	53.71	54.00	8.76	9.50	11.04	6.75
17.06	14.00	3.83	3.50	51.70	54.00	9.58	9.50	11.22	6.61
13.38	14.00	4.05	3.50	55.23	54.00	9.67	9.50	10.59	7.08
15.81	14.00	4.09	3.50	53.11	54.00	8.69	9.50	11.85	6.45
15.56	14.00	4.30	3.50	53.64	54.00	9.14	9.50	10.84	6.52
14.50	14.00	4.08	3.50	53.37	54.00	10.24	9.50	10.36	7.45
15.63	14.00	4.06	3.50	53.84	54.00	9.74	9.50	9.96	6.77
15.19	14.00	4.02	3.50	52.32	54.00	9.64	9.50	11.88	6.95
13.75	14.00	4.56	3.50	54.17	54.00	8.58	9.50	11.79	7.15
15.69	14.00	4.23	3.50	54.56	54.00	8.87	9.50	9.55	7.10
16.38	14.00	4.19	3.50	53.72	54.00	7.12	9.50	13.06	5.53
15.60	14.00	4.04	3.50	53.14	54.00	9.52	9.50	10.93	6.77
16.56	14.75	4.62	3.55	53.97	54.70	7.72	10.00	11.25	5.88
17.81	14.85	4.28	3.58	51.37	54.60	9.72	10.00	10.37	6.45
16.81	15.19	4.09	4.72	55.16	54.19	7.58	7.90	11.29	5.07
16.00	15.19	4.30	4.72	56.02	54.19	7.67	7.90	10.82	5.19
15.61	15.19	4.21	4.72	56.01	54.19	8.08	7.90	10.91	5.18
16.25	15.19	3.98	4.72	55.63	54.19	7.35	7.90	11.81	4.98
16.25	15.19	4.07	4.72	57.06	54.19	6.70	7.90	10.95	4.97
16.50	15.19	4.31	4.72	54.34	54.19	8.11	7.90	11.03	5.71
16.44	15.19	3.60	4.72	55.34	54.19	7.22	7.90	11.85	5.55
16.88	15.19	4.00	4.72	56.30	54.19	7.34	7.90	10.46	5.02
16.81	15.19	4.08	4.72	53.53	54.19	9.07	7.90	10.46	6.05
15.94	15.19	4.05	4.72	55.77	54.19	7.83	7.90	11.38	5.03

WHEAT

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Burrus Mill and Elevator Co.—Continued.		
	4397	1
	4461	2
	4545	1
	4819	1
	4904	1
	4980	1
	5100	1
	5115	3
	5441	2
Average		31
A. J. Butte Milling Co., Kansas City, Mo.		
Wheat Bran	3769	1
	4116	1
	4161	4
	4570	2
	5000	1
	5029	2
	5118	2
	5230	1
	5262	1
	5373	1
	5465	1
Average		17
Wheat Bran	4291	1
Cain Milling Co., Atchison, Kan.		
Cain's Bran	2424	1
	2556	4
	2708	2
	2908	2
	3084	1
	3152	2
	3268	2
	3508	2
	3558	3
	3645	2
	3797	1
	3913	1

BRANS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
15.56	15.19	3.63	4.72	58.08	54.19	6.76	7.90	11.12	4.85
15.50	15.19	3.94	4.72	58.90	54.19	7.01	7.90	9.47	5.18
16.56	15.19	4.26	4.72	56.52	54.19	7.06	7.90	10.32	5.28
16.88	15.19	4.10	4.72	56.05	54.19	7.93	7.90	9.81	5.23
16.56	15.19	4.05	4.72	57.10	54.19	7.35	7.90	9.76	5.18
17.00	15.19	4.31	4.72	56.81	54.19	7.48	7.90	9.19	5.21
17.19	15.19	4.14	4.72	55.65	54.19	6.73	7.90	11.08	5.21
15.13	15.19	4.08	4.72	56.83	54.19	6.79	7.90	11.72	5.45
17.56	15.19	4.03	4.72	55.08	54.19	7.75	7.90	10.02	5.56
16.39	15.19	4.06	4.72	56.12	54.19	7.46	7.90	10.71	5.26
15.38	14.00	3.84	4.50	53.60	49.00	9.51	10.00	11.15	6.52
18.25	14.00	4.35	4.50	54.03	49.00	8.60	10.00	8.55	6.22
18.00	14.00	4.13	4.50	54.68	49.00	8.22	10.00	8.85	6.12
16.90	14.00	4.67	4.50	53.72	49.00	8.42	10.00	10.28	6.01
12.19	14.00	2.75	4.50	52.10	49.00	13.75	10.00	11.02	8.19
15.75	14.00	3.83	4.50	54.27	49.00	10.29	10.00	9.39	6.47
15.25	14.00	4.43	4.50	54.33	49.00	8.66	10.00	10.83	6.50
16.13	14.00	3.68	4.50	52.43	49.00	10.56	10.00	8.95	8.25
15.00	14.00	3.55	4.50	56.71	49.00	8.73	10.00	9.53	6.48
15.81	14.00	4.30	4.50	55.72	49.00	9.05	10.00	8.26	6.86
15.75	14.00	4.23	4.50	53.78	49.00	8.67	10.00	10.97	6.60
15.85	14.00	3.98	4.50	54.12	49.00	9.50	10.00	9.80	6.75
15.62	14.85	4.09	3.58	56.55	54.60	8.98	10.00	8.45	6.31
15.31	13.00	3.94	3.00	53.40	53.00	9.63	11.00	10.95	6.77
15.73	13.00	3.80	3.00	52.41	53.00	10.85	11.00	10.14	7.07
16.23	13.00	4.14	3.00	55.00	53.00	7.52	11.00	11.70	5.41
15.31	13.00	3.75	3.00	53.85	53.00	9.64	11.00	11.01	6.44
14.19	13.00	3.75	3.00	54.13	53.00	9.50	11.00	11.59	6.84
15.50	13.00	4.42	3.00	52.14	53.00	10.38	11.00	10.62	6.94
15.25	13.00	3.65	3.00	52.98	53.00	10.05	11.00	11.34	6.73
14.63	13.00	4.08	3.00	54.07	53.00	10.09	11.00	10.30	6.83
14.56	13.00	3.96	3.00	54.48	53.00	9.93	11.00	10.21	6.86
15.13	13.00	3.89	3.00	52.61	53.00	9.48	11.00	12.17	6.72
18.03	13.00	3.71	3.00	50.54	53.00	9.64	11.00	11.25	6.83
17.19	13.00	3.81	3.00	51.19	53.00	10.42	11.00	10.44	6.95

WHEAT

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Cain Milling Co.—Continued.		
	4047	1
	4112	2
	4172	2
	4225	2
	4327	2
	4393	1
	4542	1
	4817	1
	4924	2
	4994	1
	5130	2
	5218	1
	5313	2
Average		43
Cairo Milling Co., Cairo, Ill.		
Purity Wheat Bran	3754	1
Caldwell Milling Co., Caldwell, Kan.		
Wheat Bran	5426	2
Carbondale Mill and Elevator Co., Carbondale, Ill.		
Wheat Bran	3547	1
	4175	2
	4770	1
	5183	1
Average		5
Chalfant Grain Co., Kansas City, Mo.		
Wheat Bran	2411	3
	3195	1
Average		4

BRANS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
14.13	13.00	4.07	3.00	54.10	53.00	9.34	11.00	11.81	6.55
16.06	13.00	4.29	3.00	53.96	53.00	9.21	11.00	10.28	6.20
15.44	13.00	4.16	3.00	54.10	53.00	10.16	11.00	9.55	6.59
15.13	13.00	4.04	3.00	56.41	53.00	8.30	11.00	10.20	5.92
14.75	13.00	3.86	3.00	55.23	53.00	8.47	11.00	11.57	6.12
13.94	13.00	3.93	3.00	56.52	53.00	9.58	11.00	9.83	6.20
14.19	13.00	4.30	3.00	56.48	53.00	9.07	11.00	9.89	6.07
15.25	13.00	3.93	3.00	57.44	53.00	9.26	11.00	7.80	6.32
14.63	13.00	4.08	3.00	54.96	53.00	9.21	11.00	11.10	6.02
14.06	13.00	4.23	3.00	56.38	53.00	9.32	11.00	9.73	6.28
14.13	13.00	3.84	3.00	53.63	53.00	8.60	11.00	13.55	6.25
14.13	13.00	3.93	3.00	56.22	53.00	9.38	11.00	9.80	6.54
15.31	13.00	3.91	3.00	51.92	53.00	9.36	11.00	12.60	6.90
15.13	13.00	3.98	3.00	54.17	53.00	9.45	11.00	10.78	6.49
14.87	14.00	3.69	3.50	54.79	54.00	8.53	8.00	11.91	6.21
16.00	15.06	4.07	3.34	55.94	52.04	8.62	10.08	8.79	6.58
15.50	14.55	4.38	3.10	51.97	54.40	10.45	8.90	10.84	6.86
14.94	14.55	4.35	3.10	53.99	54.40	10.32	8.90	9.21	7.19
14.25	14.55	3.79	3.10	53.69	54.40	11.47	8.90	9.64	7.16
16.63	14.55	4.45	3.10	53.00	54.40	6.89	8.90	12.52	6.51
15.34	14.55	4.24	3.10	53.16	54.40	9.78	8.90	10.55	6.93
18.25	14.85	4.12	3.58	53.43	54.60	8.78	10.00	10.03	5.39
15.38	14.85	4.35	3.58	52.65	54.60	9.46	10.00	11.51	6.65
16.81	14.85	4.24	3.58	53.04	54.60	9.12	10.00	10.77	6.02

WHEAT

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Chapin and Co., St. Louis Mo.		
Pure Wheat Bran	2195	11
	2358	17
	2471	4
	2637	2
	2809	3
Average		37
Charleston Milling Co., Charleston, Mo.		
Wheat Bran	2290	1
H. C. Cole Milling Co., Chester, Ill.		
Bran	4231	1
Collins County Mill and Elevator Co., McKinney, Tex.		
Wheat Bran	5407	1
Cumberland and Liberty Mills, Nashville, Tenn.		
Pure Wheat Bran	2201	9
	3315	1
	4082	2
	4133	2
	4262	2
	4464	1
	4573	3
	4593	3
	4673	3
	4713	9
	4801	2
	4897	2
	5017	4
	5278	3
	5325	6
Average		52
Davis Milling Co., St. Joseph, Mo.		
Pure Wheat Bran	2584	1
	2681	1
	3026	1

BRANS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
17.00	14.00	4.12	3.00	51.20	40.00	9.00	5.00	12.34	6.34
17.00	14.00	3.97	3.00	52.51	40.00	9.47	5.00	10.66	6.39
17.31	14.00	4.24	3.00	52.11	40.00	8.92	5.00	11.44	5.98
15.06	14.00	4.30	3.00	52.35	40.00	10.00	5.00	11.60	6.69
17.31	14.00	4.10	3.00	52.40	40.00	8.84	5.00	11.09	6.26
16.73	14.00	4.15	3.00	52.11	40.00	9.25	5.00	11.43	6.33
16.00	13.10	4.92	4.75	53.98	54.50	8.91	9.80	10.23	5.96
15.62	14.50	4.21	3.75	54.78	54.00	9.50	9.50	8.95	6.94
18.44	14.50	4.33	3.50	51.61	50.00	7.02	10.00	12.65	5.95
14.81	14.50	3.95	4.00	53.49	50.00	9.32	9.50	12.12	6.31
14.93	14.50	3.70	4.00	54.52	50.00	10.12	9.50	9.57	7.16
14.19	14.50	3.73	4.00	55.76	50.00	9.12	9.50	10.99	6.21
14.25	14.50	3.65	4.00	54.80	50.00	10.00	9.50	10.40	6.90
14.94	14.50	3.71	4.00	56.37	50.00	8.82	9.50	9.64	6.52
15.06	14.50	3.89	4.00	55.55	50.00	9.44	9.50	9.33	6.73
14.31	14.50	3.97	4.00	55.66	50.00	9.61	9.50	9.63	6.82
14.81	14.50	3.80	4.00	57.80	50.00	8.76	9.50	8.85	5.98
14.69	14.50	3.73	4.00	55.93	50.00	9.26	9.50	9.57	6.82
14.63	14.50	3.71	4.00	55.80	50.00	9.02	9.50	10.31	6.53
15.19	14.50	3.75	4.00	57.57	50.00	8.86	9.50	8.47	6.16
14.63	14.50	3.96	4.00	55.04	50.00	9.42	9.50	10.10	6.85
14.31	14.50	3.60	4.00	55.50	50.00	8.54	9.50	12.01	6.04
14.56	14.50	3.63	4.00	53.91	50.00	8.90	9.50	11.77	7.23
14.63	14.50	3.55	4.00	54.68	50.00	8.92	9.50	11.57	6.65
14.66	14.50	3.76	4.00	55.51	50.00	9.21	9.50	10.29	6.60
14.19	13.00	3.79	4.00	54.23	53.00	9.92	9.00	11.53	6.34
16.06	13.00	4.34	4.00	51.49	53.00	8.80	9.00	13.02	6.29
14.44	13.00	3.87	4.00	56.07	53.00	9.69	9.00	9.24	6.69

WHEAT

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Davis Milling Co.—Continued.		
	3338	2
	3487	1
	3722	2
	4150	1
	4223	2
	5105	4
	5425	2
Average		17
Eggers Milling Co., Herman, Mo.		
Wheat Bran	5341	3
Enid Mill and Elevator Co., Enid, Okla.		
Wheat Bran	2978	1
	3943	1
	4056	1
	4315	1
	4484	1
Average		5
R. H. Faucett Mill Co., St. Joseph, Mo.		
Wheat Bran	2570	2
	2857	1
	3194	1
	3261	2
	3340	2
	3495	1
	3658	1
	4119	1
	4771	1
	4813	1
	2379	1
Average		14
Fowler Commission Co., Rosedale, Kan.		
Wheat Bran	2400	7
	2562	3
	2742	1

BRANS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
14.13	13.00	3.66	4.00	55.57	53.00	8.94	9.00	11.52	6.18
18.56	13.00	4.07	4.00	51.04	53.00	8.33	9.00	12.39	5.61
16.56	13.00	4.17	4.00	55.03	53.00	7.77	9.00	10.66	5.81
15.13	13.00	3.90	4.00	56.16	53.00	8.45	9.00	10.00	6.36
15.06	13.00	3.87	4.00	56.30	53.00	8.48	9.00	10.05	6.24
14.50	13.00	4.41	4.00	53.01	53.00	8.21	9.00	11.91	7.96
15.81	13.00	3.86	4.00	55.79	53.00	7.62	9.00	10.81	6.11
15.45	13.00	3.99	4.00	54.47	53.00	8.62	9.00	11.11	6.36
16.13	15.00	4.58	4.50	55.88	54.00	8.28	9.25	8.61	6.52
17.88	18.25	4.09	3.80	54.12	55.80	7.48	8.00	10.92	5.51
17.25	18.25	3.79	3.80	53.83	55.80	9.54	8.00	10.64	4.95
17.31	18.25	3.90	3.80	54.65	55.80	7.34	8.00	11.74	5.06
17.44	18.25	3.59	3.80	56.78	55.80	7.12	8.00	10.45	4.62
17.19	18.25	3.83	3.80	55.86	55.80	8.25	8.00	9.56	5.31
17.41	18.25	3.84	3.80	55.05	55.80	7.95	8.00	10.66	5.09
14.44	12.12	3.62	5.89	54.22	60.87	9.08	2.96	12.08	6.56
14.31	12.12	3.72	5.89	55.28	60.87	8.56	2.96	11.71	6.42
15.56	12.12	3.49	5.89	53.93	60.87	8.56	2.96	11.51	6.95
14.75	12.12	3.44	5.89	53.80	60.87	9.58	2.96	11.27	7.16
14.69	12.12	3.46	5.89	53.97	60.87	9.65	2.96	11.41	6.82
14.75	12.12	3.71	5.89	53.85	60.87	9.39	2.96	11.12	7.18
14.25	12.12	3.48	5.89	55.60	60.87	9.44	2.96	10.52	6.71
15.31	12.12	3.84	5.89	56.18	60.87	8.45	2.96	9.48	6.74
14.00	12.12	4.21	5.89	54.07	60.87	10.59	2.96	9.57	7.56
15.56	12.12	3.92	5.89	58.44	60.87	7.82	2.96	8.14	6.12
14.50	12.12	3.70	5.89	56.18	60.87	8.27	2.96	10.53	6.82
14.74	12.12	3.69	5.89	55.05	60.87	9.03	2.96	10.67	6.32
16.56	14.13	3.83	3.00	53.09	55.31	10.29	10.31	9.55	6.68
15.38	14.13	4.30	3.00	51.09	55.31	10.19	10.31	11.87	7.17
16.59	14.13	4.17	3.00	49.55	55.31	10.24	10.31	12.62	6.83

WHEAT

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Fowler Commission Co.—Continued.		
	2796	2
	2844	2
	2941	1
	3039	3
	3081	1
	3154	2
	3373	1
	3431	2
	3489	3
	3537	2
	3631	2
	4052	1
	4385	1
	4478	1
	4693	1
	4902	1
Average		37
Garvin Flour and Grain Co., Witchita, Kan.		
Wheat Bran	3532	1
Goran Grain and Elevator Co., Wichita, Kan.		
Wheat Bran	2240	8
	2384	2
Average		10
J. S. Gordon and Co., Beaumont, Tex.		
Wheat Bran	3625	1
H. L. Halliday, Cairo, Ill.		
Wheat Bran	4134	2
	4247	1
	4560	1
	4592	3
	4638	1
	4830	1
	4843	1
	4996	1

BRANS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
16.75	14.13	3.86	3.00	54.80	55.31	9.11	10.31	9.37	6.11
16.69	14.13	4.27	3.00	51.67	55.31	9.77	10.31	10.86	6.74
17.50	14.13	4.30	3.00	55.01	55.31	7.57	10.31	10.20	5.42
14.50	14.13	4.24	3.00	53.99	55.31	9.73	10.31	10.70	6.84
18.86	14.13	3.35	3.00	50.53	55.31	9.35	10.31	11.47	6.44
18.19	14.13	4.29	3.00	53.09	55.31	8.14	10.31	10.67	5.62
19.25	14.13	3.54	3.00	49.39	55.31	10.65	10.31	9.90	7.27
14.87	14.13	4.24	3.00	53.32	55.31	9.62	10.31	11.05	6.90
17.06	14.13	3.55	3.00	49.48	55.31	11.73	10.31	10.93	7.25
16.44	14.13	4.51	3.00	54.19	55.31	8.39	10.31	10.59	5.88
19.31	14.13	4.44	3.00	53.85	55.31	5.55	10.31	11.88	4.97
18.06	14.13	3.72	3.00	50.19	55.31	8.47	10.31	13.07	6.49
14.75	14.13	3.82	3.00	53.61	55.31	10.24	10.31	10.72	6.86
17.56	14.13	4.33	3.00	54.80	55.31	8.14	10.31	8.65	6.52
16.13	14.13	4.85	3.00	53.48	55.31	7.91	10.31	11.47	6.16
15.88	14.13	4.81	3.00	53.89	55.31	9.27	10.31	9.88	6.27
16.86	14.13	4.12	3.00	52.59	55.31	9.18	10.31	10.81	6.44

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
16.56	14.00	4.05	3.50	53.30	51.00	9.43	11.50	10.99	5.67

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
16.81	14.85	3.96	3.58	53.49	54.60	9.25	10.00	10.36	6.13
16.19	14.85	3.58	3.58	50.61	54.60	10.93	10.00	11.87	6.82
16.50	14.85	3.77	3.58	52.05	54.60	10.09	10.00	11.12	6.47

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
17.69	14.50	4.02	3.50	54.60	50.00	8.07	10.00	10.42	5.20

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
15.87	14.50	4.11	4.00	54.99	55.00	8.52	9.50	10.17	6.34
16.25	14.50	4.74	4.00	55.31	55.00	8.91	9.50	8.63	6.16
15.38	14.50	4.28	4.00	55.52	55.00	7.85	9.50	11.32	5.65
16.00	14.50	4.53	4.00	55.43	55.00	7.89	9.50	9.66	6.49
15.69	14.50	4.36	4.00	55.12	55.00	7.58	9.50	11.19	6.06
17.06	14.50	4.58	4.00	54.70	55.00	7.78	9.50	9.44	6.44
16.19	14.50	4.48	4.00	54.27	55.00	7.92	9.50	11.03	6.11
16.38	14.50	4.16	4.00	55.16	55.00	8.06	9.50	10.29	5.95

	WHEAT	
Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
H. L. Halliday—Continued.		
	5028	2
	5140	1
	5288	1
	5385	1
Average		16
Higginsville Milling Co., Higginsville, Mo.		
Wheat Bran	2475	2
	2874	2
	3377	1
	3522	2
	3779	1
	3944	1
	4146	1
	4292	1
	4295	3
	4383	1
	4456	2
	4742	1
	4871	1
	2373	1
	4949	1
	5030	3
	5081	1
	5371	1
Average		26
R. J. House and Co., Kansas City, Mo.		
Wheat Bran	3082	1
	3311	1
Average		2
Hunter Bros.' Milling Co., Kansas City, Mo.		
Pure Wheat Bran..	2919	1
	3523	2
	4054	1
	4118	1
	4199	1
	4254	1
Average		7

BRANS.

PROTEIN		FAT		CARBOHY-DRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
16.31	14.50	4.37	4.00	54.28	55.00	8.72	9.50	9.74	6.58
16.38	14.50	4.43	4.00	53.90	55.00	7.94	9.50	10.17	7.18
16.50	14.50	4.24	4.00	56.51	55.00	7.87	9.50	8.43	6.45
15.25	14.50	4.16	4.00	52.19	55.00	9.42	9.50	11.42	7.56
16.11	14.50	4.37	4.00	54.78	55.00	8.21	9.50	10.12	6.41
16.81	14.23	4.24	2.60	52.15	54.39	8.98	9.50	11.39	6.43
18.00	14.23	3.93	2.60	52.04	54.39	8.48	9.50	10.22	7.33
14.50	14.23	4.22	2.60	53.53	54.39	9.49	9.50	11.37	6.89
15.00	14.23	4.17	2.60	55.88	54.39	8.50	9.50	10.29	6.16
15.31	14.23	5.04	2.60	56.80	54.39	7.31	9.50	9.96	5.58
15.75	14.23	3.94	2.60	55.16	54.39	7.17	9.50	10.86	7.12
14.75	14.23	3.89	2.60	54.49	54.39	9.27	9.50	10.98	6.62
16.00	14.23	4.47	2.60	55.91	54.39	8.58	9.50	9.05	5.99
15.62	14.23	3.99	2.60	54.96	54.39	9.55	9.50	9.53	6.35
14.81	14.23	4.25	2.60	53.93	54.39	9.46	9.50	11.19	6.36
15.50	14.23	4.54	2.60	56.01	54.39	7.38	9.50	10.91	5.66
15.50	14.23	4.68	2.60	54.06	54.39	8.51	9.50	10.88	6.39
15.38	14.23	4.97	2.60	54.99	54.39	8.36	9.50	10.19	6.11
16.19	14.23	4.50	2.60	51.91	54.39	9.26	9.50	12.05	6.09
15.88	14.23	4.85	2.60	55.02	54.39	8.13	9.50	10.08	6.04
16.25	14.23	4.53	2.60	54.08	54.39	9.27	9.50	9.41	6.46
14.31	14.23	3.84	2.60	51.61	54.39	10.27	9.50	12.93	7.04
16.22	14.23	4.69	2.60	54.72	54.39	9.00	9.50	8.45	6.92
15.65	14.23	4.38	2.60	54.29	54.39	8.72	9.50	10.54	6.42
16.75	17.70	4.29	5.70	54.47	50.09	7.77	10.40	11.24	5.48
17.00	17.70	4.19	5.70	52.33	50.09	7.95	10.40	10.74	7.79
16.88	17.70	4.24	5.70	53.40	50.09	7.86	10.40	10.99	6.63
15.13	14.00	4.12	3.50	52.08	54.00	11.04	10.00	10.91	6.72
15.50	14.00	4.00	3.50	54.57	54.00	9.13	10.00	10.55	6.35
15.94	14.00	4.06	3.50	51.60	54.00	8.73	10.00	11.75	7.92
17.06	14.00	4.37	3.50	54.69	54.00	8.32	10.00	9.79	5.77
18.06	14.00	3.70	3.50	53.01	54.00	8.89	10.00	10.24	6.10
16.81	14.00	4.48	3.50	55.70	54.00	7.71	10.00	9.33	5.97
16.41	14.00	4.12	3.50	53.61	54.00	8.97	10.00	10.42	6.47

WHEAT

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Kansas Milling Co., Wichita, Kan.		
Climax Wheat Bran	3229	1
Wheat Bran	2730	3
Kansas City Grain and Flour Co., Kansas City, Mo.		
Wheat Bran	2428	1
Kelly Milling Co., Kansas City, Mo.		
Pure Wheat Bran	3433	3
	3524	3
	3579	2
	3629	1
	4301	6
	4510	3
	4764	2
	5433	1
Average		22
Wheat Bran	2253	2
	2543	3
	2695	2
	2815	1
	2855	2
	2982	1
	3149	1
	3235	1
	3307	1
	3546	1
	4196	1
	4235	5
	4365	1
Average		22
Wheat Bran	2939	1
Kelly-Lysle Milling Co., Leavenworth, Kan.		
Pure Wheat Bran	2404	3
	2507	3
	2632	3

BRANS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
17.19	15.50	3.95	4.00	53.30	53.00	8.35	8.50	11.65	5.56
17.81	16.75	3.71	4.04	52.67	53.32	8.01	8.91	11.91	5.89
17.44	12.00	4.06	5.00	52.66	45.00	9.38	15.00	10.44	6.02
16.25	7.40	4.52	4.08	55.02	49.00	7.61	14.18	10.82	5.78
16.50	7.40	4.58	4.08	54.85	49.00	7.82	14.18	10.40	5.85
16.50	7.40	4.49	4.08	53.46	49.00	8.71	14.18	10.39	6.45
15.88	7.40	4.42	4.08	53.18	49.00	8.82	14.18	11.64	6.06
16.50	7.40	4.13	4.08	54.41	49.00	8.63	14.18	10.17	6.16
16.00	7.40	4.53	4.08	54.48	49.00	8.00	14.18	10.99	6.00
17.25	7.40	4.55	4.08	53.68	49.00	8.90	14.18	9.64	5.98
16.00	7.40	4.42	4.08	54.29	49.00	10.14	14.18	8.31	6.84
16.36	7.40	4.45	4.08	54.17	49.00	8.58	14.18	10.30	6.14
17.56	14.85	4.08	3.58	54.14	54.60	8.09	10.00	9.96	6.17
16.88	14.85	4.20	3.58	53.45	54.60	8.58	10.00	11.20	5.69
16.38	14.85	4.38	3.58	52.65	54.60	8.93	10.00	11.48	6.18
16.63	14.85	4.52	3.58	53.90	54.60	8.62	10.00	10.38	5.95
17.25	14.85	4.63	3.58	53.80	54.60	7.41	10.00	11.51	5.40
17.57	14.85	4.62	3.58	55.21	54.60	7.35	10.00	10.07	5.50
16.56	14.85	4.44	3.58	54.92	54.60	7.17	10.00	11.45	5.46
16.56	14.85	4.40	3.58	54.32	54.60	7.97	10.00	11.28	5.47
16.50	14.85	4.50	3.58	53.74	54.60	8.13	10.00	11.52	5.61
16.69	14.85	4.67	3.58	53.65	54.60	7.77	10.00	11.30	5.92
17.56	14.85	4.22	3.58	54.26	54.60	7.78	10.00	10.31	5.86
16.88	14.85	4.27	3.58	54.85	54.60	8.37	10.00	9.64	5.99
16.13	14.85	4.32	3.58	53.27	54.60	8.45	10.00	11.65	6.18
16.86	14.85	4.40	3.58	54.01	54.60	8.04	10.00	10.90	5.79
17.43	15.00	4.40	3.50	54.40	53.00	7.32	9.00	11.16	5.29
15.69	15.00	3.93	4.00	53.08	52.00	10.41	10.00	9.83	7.06
17.56	15.00	4.07	4.00	51.77	52.00	9.12	10.00	11.25	6.23
14.98	15.00	3.75	4.00	52.15	52.00	10.87	10.00	11.14	7.11

WHEAT

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Kelly-Lysle Milling Co.—Continued.		
	2961	2
	3072	4
	3333	3
	3441	2
	3657	1
	3789	3
	3876	3
	4000	1
	4137	4
	4285	1
	4337	1
	4554	1
	4633	1
	4675	2
	4722	1
	4754	2
	4845	1
	4894	2
	4927	1
	4985	1
	5022	6
	5095	1
	5171	3
	5227	1
	5271	3
	5379	2
	5419	1
	5443	2
Average		65
W. T. Kemper Mill and Elevator Co., Kansas City, Mo.		
Kemper Bran	2340	8
	2530	2
	2631	3
Average		13
Wheat Bran	3379	1
	4078	1
	4229	1
	5046	1
Average		4

BRANS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
15.56	15.00	4.13	4.00	54.26	52.00	9.33	10.00	10.14	6.58
15.13	15.00	3.93	4.00	52.11	52.00	10.49	10.00	11.48	6.86
14.38	15.00	3.83	4.00	52.19	52.00	11.04	10.00	11.32	7.24
15.63	15.00	3.50	4.00	51.20	52.00	11.07	10.00	11.32	7.28
14.31	15.00	4.05	4.00	52.75	52.00	11.06	10.00	10.66	7.17
15.31	15.00	3.99	4.00	54.05	52.00	10.23	10.00	9.39	7.03
14.56	15.00	3.82	4.00	52.52	52.00	11.43	10.00	10.67	7.00
14.38	15.00	3.68	4.00	53.16	52.00	10.35	10.00	10.54	7.89
15.44	15.00	3.58	4.00	52.75	52.00	10.41	10.00	10.65	7.17
14.81	15.00	3.93	4.00	54.93	52.00	11.04	10.00	7.94	7.35
14.31	15.00	4.33	4.00	51.81	52.00	10.70	10.00	11.68	7.17
14.94	15.00	3.90	4.00	53.50	52.00	10.04	10.00	10.29	7.33
14.13	15.00	3.97	4.00	52.91	52.00	10.89	10.00	10.84	7.26
14.31	15.00	4.02	4.00	52.91	52.00	10.43	10.00	10.98	7.35
15.06	15.00	4.29	4.00	52.70	52.00	10.37	10.00	10.10	7.48
14.75	15.00	4.05	4.00	53.03	52.00	9.98	10.00	11.68	6.51
15.19	15.00	4.08	4.00	51.50	52.00	10.19	10.00	11.60	7.44
15.44	15.00	3.92	4.00	55.90	52.00	8.34	10.00	10.36	6.04
15.06	15.00	4.30	4.00	52.62	52.00	9.60	10.00	11.60	6.82
15.19	15.00	4.16	4.00	54.29	52.00	9.58	10.00	9.67	7.11
14.25	15.00	3.87	4.00	53.59	52.00	9.81	10.00	11.70	6.78
14.81	15.00	3.82	4.00	52.40	52.00	10.12	10.00	11.54	7.31
14.25	15.00	3.86	4.00	49.98	52.00	9.91	10.00	9.91	12.09
14.19	15.00	3.73	4.00	56.02	52.00	9.67	10.00	9.61	6.78
16.31	15.00	3.99	4.00	53.28	52.00	9.00	10.00	10.64	6.78
16.47	15.00	4.18	4.00	52.80	52.00	8.45	10.00	11.29	6.81
15.13	15.00	3.86	4.00	52.95	52.00	10.25	10.00	10.41	7.40
16.06	15.00	3.70	4.00	53.72	52.00	9.22	10.00	10.45	6.85
15.08	15.00	3.94	4.00	53.00	52.00	10.11	10.00	10.67	7.20
17.00	14.50	4.13	5.60	51.06	50.40	9.43	13.50	11.76	6.62
17.63	14.50	4.39	5.60	53.14	50.40	9.33	13.50	9.13	6.38
15.56	14.50	3.60	5.60	53.47	50.40	9.52	13.50	11.21	6.64
16.73	14.50	4.04	5.60	52.56	50.40	9.42	13.50	10.70	6.55
17.81	14.50	4.10	4.00	52.65	53.50	8.28	9.50	11.24	5.92
14.13	14.50	3.86	4.00	58.02	53.50	6.95	9.50	11.55	5.49
16.63	14.50	3.89	4.00	51.90	53.50	11.17	9.50	8.63	7.78
17.44	14.50	4.27	4.00	53.35	53.50	8.96	9.50	9.25	6.73
16.50	14.50	4.03	4.00	53.98	53.50	8.84	9.50	10.17	6.48

WHEAT

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Land Milling Co., Neodesha, Kan.		
Wheat Bran	2519	1
	4287	1
	5460	1
Average		3
Mose H. Land Milling Co., Marshall, Mo.		
Wheat Bran	4117	1
	4323	2
Average		3
H. T. Lawler Mill and Trading Co., Ltd., New Orleans, La.		
"M" Wheat Bran (contains oat hulls)	2552	1
	2745	1
	5009	1
Average		3
Leavenworth Milling Co., Leavenworth, Kan.		
Pure Wheat Bran	2254	2
	2364	3
	2606	2
	2697	3
	2799	2
	2912	2
	2999	1
	3079	2
	3190	1
	3399	2
	3493	1
	3588	1
	3698	2
	4051	1
	4111	2
	4214	1
	4391	1
	4459	2
	4532	2
	4810	1
	4841	1
	4919	3

BRANS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
17.24	15.11	3.79	3.73	50.78	53.24	10.11	9.17	11.49	6.59
16.31	15.11	3.95	3.73	54.42	53.24	9.07	9.17	10.57	5.68
16.44	15.11	4.22	3.73	54.26	53.24	8.43	9.17	10.02	6.63
—	—	—	—	—	—	—	—	—	—
16.66	15.11	3.99	3.73	53.16	53.24	9.20	9.17	10.69	6.30
14.75	13.75	4.01	2.80	55.82	49.90	9.82	16.25	9.48	6.12
15.25	13.75	4.08	2.80	54.05	49.90	8.56	16.25	12.00	6.06
—	—	—	—	—	—	—	—	—	—
15.00	13.75	4.04	2.80	54.94	49.90	9.19	16.25	10.74	6.09
14.44	12.50	3.51	3.30	54.39	50.00	9.23	10.00	11.93	6.50
14.56	12.50	3.25	3.30	54.24	50.00	9.50	10.00	11.59	6.86
14.13	12.50	4.14	3.30	58.02	50.00	8.22	10.00	9.46	6.03
—	—	—	—	—	—	—	—	—	—
14.38	12.50	3.63	3.30	55.56	50.00	8.98	10.00	10.99	6.46
16.19	15.19	4.13	3.85	52.45	52.85	10.11	9.15	10.27	6.85
17.81	15.19	4.13	3.85	50.54	52.85	10.20	9.15	10.49	6.83
16.99	15.19	4.15	3.85	51.86	52.85	10.27	9.15	10.29	6.44
15.94	15.19	4.07	3.85	52.52	52.85	9.49	9.15	11.05	6.93
15.88	15.19	4.02	3.85	53.70	52.85	9.53	9.15	10.35	6.85
16.56	15.19	3.96	3.85	52.87	52.85	9.01	9.15	11.24	6.36
15.88	15.19	3.83	3.85	52.08	52.85	9.21	9.15	12.67	6.33
15.94	15.19	3.76	3.85	51.43	52.85	10.15	9.15	11.43	7.29
15.75	15.19	4.15	3.85	51.88	52.85	9.84	9.15	11.47	6.91
16.44	15.19	3.67	3.85	51.77	52.85	10.17	9.15	10.80	7.15
17.06	15.19	3.91	3.85	51.28	52.85	9.62	9.15	11.37	6.76
15.81	15.19	3.66	3.85	51.11	52.85	9.91	9.15	12.52	6.99
16.25	15.19	4.02	3.85	53.09	52.85	9.40	9.15	10.59	6.65
15.06	15.19	4.27	3.85	50.70	52.85	9.64	9.15	13.70	6.63
15.13	15.19	4.26	3.85	54.28	52.85	9.80	9.15	9.86	6.67
15.06	15.19	4.15	3.85	53.22	52.85	10.33	9.15	10.34	6.90
14.50	15.19	4.13	3.85	54.87	52.85	10.17	9.15	9.55	6.78
14.94	15.19	4.26	3.85	54.89	52.85	9.54	9.15	9.64	6.73
14.63	15.19	4.33	3.85	53.19	52.85	9.95	9.15	11.22	6.68
15.06	15.19	4.70	3.85	55.13	52.85	9.63	9.15	8.66	6.82
15.19	15.19	4.28	3.85	52.51	52.85	10.05	9.15	10.61	7.36
14.63	15.19	3.98	3.85	53.40	52.85	9.28	9.15	11.76	6.95

WHEAT

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Leavenworth Milling Co.—Continued.		
	4997	1
	5224	1
	5291	1
	5391	2
Average		43
Lukens Milling Co., Atchison, Kan.		
Wheat Bran	2654	1
	2902	1
	3044	1
	3241	2
	3993	1
	4053	1
	4249	1
	4564	1
	4986	1
	5058	1
	5154	1
	5377	1
Average		13
Majestic Milling Co., Aurora, Mo.		
Wheat Bran	2515	1
McEwen Grain Co., Kansas City, Mo.		
Wheat Bran	2243	4
	3374	1
Average		5
Missouri and Kansas Grain Co., Neosho, Mo.		
Pure Wheat Bran	2209	6
	2446	3
	2560	4
	2794	2
	2825	5
	2885	4
	2994	1
	3080	1

BRANS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
15.00	15.19	4.13	3.85	52.84	52.85	10.16	9.15	11.22	6.65
14.81	15.19	3.92	3.85	54.55	52.85	10.11	9.15	9.56	7.05
15.00	15.19	4.26	3.85	53.85	52.85	10.47	9.15	8.96	7.46
15.50	15.19	4.10	3.85	56.38	52.85	9.17	9.15	8.59	6.26
—	—	—	—	—	—	—	—	—	—
15.65	15.19	4.09	3.85	52.92	52.85	9.82	9.15	10.70	6.82
15.13	11.00	4.37	3.50	55.89	50.00	7.41	12.00	11.59	5.61
16.31	11.00	3.35	3.50	51.77	50.00	10.76	12.00	10.69	7.12
15.31	11.00	3.56	3.50	54.04	50.00	10.23	12.00	9.71	7.15
15.31	11.00	3.41	3.50	52.83	50.00	10.35	12.00	11.45	6.65
15.75	11.00	3.77	3.50	53.18	50.00	9.34	12.00	11.39	6.57
14.63	11.00	3.51	3.50	53.75	50.00	9.38	12.00	12.14	6.59
13.69	11.00	3.00	3.50	57.44	50.00	10.53	12.00	9.07	6.27
15.19	11.00	4.07	3.50	53.29	50.00	9.82	12.00	11.16	6.52
15.50	11.00	4.26	3.50	54.52	50.00	9.17	12.00	9.43	7.12
15.19	11.00	4.69	3.50	52.61	50.00	9.20	12.00	11.44	6.87
15.69	11.00	3.76	3.50	53.22	50.00	10.00	12.00	10.70	6.63
17.38	11.00	4.29	3.50	53.32	50.00	8.72	12.00	9.86	6.43
—	—	—	—	—	—	—	—	—	—
15.42	11.00	3.83	3.50	53.82	50.00	9.58	12.00	10.72	6.63
15.52	14.60	3.99	3.75	52.29	55.00	10.15	8.00	12.11	5.94
17.19	14.10	4.25	6.50	54.36	58.10	7.75	9.30	10.62	5.83
16.81	14.10	4.28	6.50	54.85	58.10	8.46	9.30	9.45	6.15
—	—	—	—	—	—	—	—	—	—
17.00	14.10	4.26	6.50	54.61	58.10	8.10	9.30	10.04	5.99
16.63	9.00	4.40	3.00	53.39	54.00	8.58	20.00	11.14	5.86
17.13	9.00	4.07	3.00	52.36	54.00	9.96	20.00	9.89	6.59
16.86	9.00	3.82	3.00	52.36	54.00	9.20	20.00	11.39	6.37
16.13	9.00	4.31	3.00	54.74	54.00	8.78	20.00	10.15	5.89
16.81	9.00	4.19	3.00	51.90	54.00	8.87	20.00	12.14	6.09
16.30	9.00	4.31	3.00	51.57	54.00	11.10	20.00	9.76	6.96
18.44	9.00	3.92	3.00	51.92	54.00	8.94	20.00	10.72	6.06
18.00	9.00	3.52	3.00	50.40	54.00	10.20	20.00	11.03	6.85

WHEAT

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Missouri and Kansas Grain Co.—Continued.		
	3153	4
	3396	4
	3576	4
	3615	5
	3720	1
	3800	1
	3907	1
	4001	1
	4194	1
	4310	7
	4520	3
	4612	4
	4763	2
	5004	7
	5213	4
	5334	5
Average		80
Midland Mill and Elevator Co., Muscogee, Okla.		
Wheat Bran	3693	1
Midler's Milling Co., Fort Worth, Tex.		
Wheat Bran	5285	1
	5326	4
	5420	2
Average		7
Nelson Grain Co., Kansas City, Mo.		
Pure Wheat Bran	2439	2
	3412	1
	3628	1
	4829	1
	4929	1
	5220	1
	5297	1
Average		8

BRANS.

PROTEIN		FAT		CARBOHY-DRATES		FIBER		WATER	Ash
Found %	G	Found %	Guarant'd %	Foun	Guarant'd %	%	Guarant'd %	Found %	Found %
17.50	9.00	3.92	3.00	53.97	54.00	8.27	20.00	10.68	5.66
16.94	9.00	3.68	3.00	51.47	54.00	10.18	20.00	10.28	7.45
16.94	9.00	3.85	3.00	51.17	54.00	10.48	20.00	10.89	6.67
16.81	9.00	4.19	3.00	53.19	54.00	9.72	20.00	9.60	6.49
17.31	9.00	3.80	3.00	52.16	54.00	8.78	20.00	11.11	6.84
14.25	9.00	3.75	3.00	52.26	54.00	11.29	20.00	11.35	7.10
16.75	9.00	3.82	3.00	51.84	54.00	9.52	20.00	11.11	6.96
14.87	9.00	4.25	3.00	54.01	54.00	9.93	20.00	9.83	7.11
15.06	9.00	4.24	3.00	51.17	54.00	11.38	20.00	11.58	6.57
17.31	9.00	3.92	3.00	52.76	54.00	9.08	20.00	10.42	6.51
15.44	9.00	4.30	3.00	53.41	54.00	9.96	20.00	10.22	6.67
16.81	9.00	4.61	3.00	52.36	54.00	8.95	20.00	10.99	6.28
14.50	9.00	3.82	3.00	54.37	54.00	10.64	20.00	9.72	6.95
17.56	9.00	4.19	3.00	51.65	54.00	9.10	20.00	11.08	6.43
15.00	9.00	4.33	3.00	52.13	54.00	10.65	20.00	10.54	7.35
15.81	9.00	3.92	3.00	55.22	54.00	9.02	20.00	9.24	6.79
16.47	9.00	4.05	3.00	52.57	54.00	9.69	20.00	10.62	6.60
17.81	9.00	4.15	4.00	55.00	70.00	7.82	8.00	10.14	5.08
17.69	14.00	4.29	4.05	54.65	54.47	7.92	7.31	8.97	6.48
17.69	14.00	4.44	4.05	51.69	54.47	8.02	7.31	11.34	6.82
17.25	14.00	4.45	4.05	52.42	54.47	8.72	7.31	10.74	6.42
17.54	14.00	4.39	4.05	52.93	54.47	8.22	7.31	10.35	6.57
17.25	8.30	3.88	2.40	52.23	60.00	9.78	15.40	10.40	6.46
16.75	8.30	4.19	2.40	53.39	60.00	9.06	15.40	10.50	6.11
15.94	8.30	4.25	2.40	51.99	60.00	9.61	15.40	11.92	6.25
15.94	8.30	4.70	2.40	53.72	60.00	9.02	15.40	9.93	6.69
17.13	8.30	4.14	2.40	51.74	60.00	9.50	15.40	10.80	6.69
14.44	8.30	3.94	2.40	53.90	60.00	10.76	15.40	10.36	6.60
15.44	8.30	4.72	2.40	54.49	60.00	8.67	15.40	9.93	6.75
16.13	8.30	4.26	2.40	53.06	60.00	9.50	15.40	10.55	6.50

WHEAT

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Neosho Milling Co., Neosho, Mo.		
Wheat Bran	2597	1
	3232	1
Average		2
New Athens Milling Co., New Athens, Ill.		
Pure Wheat Bran	2352	1
	2525	1
	2977	1
	3308	1
	3411	1
	5098	1
	5181	1
Average		7
New Era Milling Co., Arkansas City, Kan.		
Wheat Bran	4203	1
	4644	1
	4993	1
	5263	1
	5447	2
Average		6
Oklahoma City Mill and Elevator Co., Oklahoma City, Okla.		
Wheat Bran	2675	2
	2837	1
	2976	1
	3231	1
	3375	1
	3656	1
	4088	1
	4255	1
	4408	2
	4563	1
	4588	2
	4834	1
	4880	1
	4931	1
	4961	2
	5146	1

BRANS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
17.54	13.00	4.20	3.30	54.03	45.00	8.19	10.00	11.34	4.70
14.19	13.00	3.97	3.30	55.69	45.00	9.79	10.00	9.35	7.01
15.87	13.00	4.08	3.30	54.86	45.00	8.99	10.00	10.35	5.85
15.50	14.00	4.28	3.20	54.66	54.00	8.02	7.50	11.80	5.74
16.93	14.00	4.09	3.20	54.31	54.00	8.04	7.50	10.58	6.05
16.06	14.00	4.59	3.20	55.18	54.00	7.64	7.50	10.49	6.04
16.31	14.00	4.50	3.20	54.28	54.00	8.23	7.50	10.71	5.97
16.19	14.00	4.41	3.20	53.30	54.00	8.72	7.50	11.21	6.17
14.75	14.00	3.81	3.20	54.01	54.00	9.38	7.50	11.27	6.78
15.31	14.00	4.06	3.20	53.02	54.00	7.70	7.50	13.63	6.28
15.86	14.00	4.25	3.20	54.11	54.00	8.25	7.50	11.38	6.15
16.63	14.00	3.44	3.50	55.27	54.00	8.72	10.00	10.42	5.52
16.50	14.00	3.86	3.50	54.13	54.00	8.86	10.00	11.11	5.54
17.22	14.00	4.27	3.50	56.00	54.00	8.75	10.00	8.66	5.10
16.75	14.00	3.48	3.50	54.81	54.00	9.20	10.00	9.25	6.51
15.06	14.00	4.30	3.50	53.70	54.00	9.52	10.00	10.46	6.96
16.43	14.00	3.87	3.50	54.78	54.00	9.01	10.00	9.98	5.93
15.81	16.94	4.46	4.50	49.90	53.54	9.48	8.53	13.66	6.69
16.75	16.94	4.07	4.50	49.34	53.54	9.57	8.53	13.50	6.77
16.44	16.94	4.42	4.50	49.91	53.54	10.20	8.53	11.77	7.26
14.63	16.94	4.27	4.50	52.58	53.54	9.88	8.53	11.95	6.69
14.31	16.94	4.24	4.50	53.05	53.54	9.53	8.53	11.96	6.91
15.31	16.94	3.87	4.50	52.84	53.54	10.36	8.53	10.75	6.87
14.87	16.94	4.10	4.50	52.86	53.54	9.61	8.53	11.46	7.10
15.50	16.94	4.43	4.50	55.00	53.54	8.85	8.53	9.31	6.91
15.13	16.94	4.41	4.50	53.71	53.54	9.05	8.53	10.71	6.99
14.56	16.94	4.35	4.50	52.73	53.54	9.55	8.53	11.51	7.30
14.13	16.94	4.46	4.50	53.27	53.54	9.85	8.53	11.11	7.18
14.69	16.94	4.89	4.50	57.08	53.54	8.80	8.53	9.51	5.03
14.06	16.94	4.21	4.50	52.52	53.54	9.59	8.53	12.37	7.25
14.94	16.94	3.96	4.50	53.66	53.54	10.28	8.53	9.91	7.25
14.56	16.94	4.00	4.50	52.24	53.54	9.88	8.53	12.13	7.19
16.00	16.94	4.00	4.50	51.66	53.54	8.02	8.53	13.33	6.39

WHEAT

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Oklahoma City Mill and Elevator Co.—Continued.		
	5257	1
	5375	1
	5418	1
	5451	1
Average		24
Pearl Roller Mills, Oswego, Kan.		
Wheat Bran	2271	2
	2442	5
	2621	1
	2795	2
	2962	2
	3191	1
	3282	2
	3439	2
	3776	2
	3868	1
	4014	2
	4180	1
	4278	2
	4300	3
	4475	1
	4905	1
	4948	1
	4999	1
	5376	1
	5410	1
	5436	1
	5469	1
Average		26
Geo. P. Plant Milling Co., St. Louis, Mo.		
Pearl Wheat Bran	2365	3
	2470	7
	2577	2
	2706	1
	2755	2
	2792	2
	2918	1
	2995	1
	3118	1

BRANS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
16.75	16.94	3.08	4.50	53.72	53.54	7.75	8.53	12.00	6.70
15.72	16.94	3.93	4.50	55.53	53.54	9.80	8.53	8.07	6.95
15.78	16.94	4.10	4.50	53.06	53.54	9.55	8.53	10.38	7.13
17.06	16.94	3.87	4.50	53.35	53.54	8.42	8.53	11.15	6.15
15.35	16.94	4.16	4.50	52.90	53.54	9.40	8.53	11.33	6.86
18.81	14.69	3.81	3.92	52.11	56.84	7.42	8.30	12.34	5.51
16.50	14.69	4.11	3.92	53.18	56.84	9.54	8.30	9.98	6.69
19.49	14.69	3.49	3.92	54.53	56.84	6.22	8.30	11.45	4.82
18.88	14.69	3.56	3.92	53.72	56.84	8.16	8.30	10.15	5.53
17.94	14.69	3.73	3.92	53.65	56.84	8.28	8.30	10.37	6.03
18.91	14.69	3.68	3.92	53.69	56.84	6.23	8.30	12.63	4.86
16.88	14.69	3.93	3.92	57.24	56.84	7.76	8.30	9.36	4.83
17.31	14.69	3.91	3.92	54.99	56.84	7.42	8.30	11.23	5.14
16.44	14.69	4.08	3.92	55.69	56.84	8.13	8.30	9.90	5.76
14.87	14.69	4.28	3.92	53.02	56.84	9.98	8.30	10.46	7.39
18.25	14.69	3.81	3.92	55.13	56.84	6.84	8.30	10.75	5.22
16.13	14.69	3.59	3.92	51.78	56.84	11.32	8.30	9.92	7.26
16.44	14.69	3.79	3.92	57.35	56.84	7.40	8.30	9.55	5.47
16.44	14.69	3.68	3.92	55.88	56.84	8.15	8.30	10.34	5.51
18.75	14.69	4.08	3.92	55.18	56.84	7.04	8.30	9.70	5.25
16.75	14.69	3.72	3.92	57.80	56.84	6.67	8.30	10.26	4.80
17.63	14.69	3.50	3.92	55.52	56.84	6.39	8.30	12.30	4.66
16.38	14.69	3.54	3.92	56.90	56.84	6.71	8.30	11.90	4.57
16.91	14.69	4.08	3.92	59.31	56.84	6.92	8.30	7.47	5.31
17.00	14.69	3.54	3.92	55.26	56.84	6.65	8.30	12.04	5.51
17.19	14.69	4.56	3.92	53.74	56.84	8.79	8.30	8.91	6.81
16.88	14.69	3.76	3.92	54.59	56.84	6.85	8.30	12.42	5.50
17.31	14.69	3.83	3.92	55.01	56.84	7.67	8.30	10.61	5.57
15.75	15.43	4.32	3.27	52.82	54.63	9.48	9.72	11.06	6.57
15.56	15.43	4.44	3.27	52.47	54.63	9.24	9.72	11.90	6.39
16.06	15.43	4.40	3.27	51.60	54.63	8.44	9.72	12.55	6.95
16.63	15.43	4.49	3.27	52.23	54.63	8.39	9.72	12.33	5.93
15.91	15.43	3.99	3.27	53.50	54.63	9.20	9.72	10.92	6.48
15.86	15.43	4.12	3.27	54.45	54.63	8.93	9.72	10.22	6.42
16.63	15.43	4.42	3.27	54.11	54.63	8.41	9.72	10.54	5.89
16.88	15.43	4.54	3.27	52.30	54.63	8.12	9.72	12.17	5.99
15.56	15.43	4.12	3.27	50.98	54.63	9.77	9.72	12.96	6.61

WHEAT

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Geo. P. Plant Milling Co.—Contniued.		
	3317	1
	3389	3
	3520	6
	3590	1
	3798	1
	3840	2
	4009	3
	4219	1
	4322	2
	4418	1
	4458	2
	4589	2
	4629	2
	4670	5
	4712	4
	4821	1
	4856	3
	4922	3
	4954	3
	4968	2
	5144	1
	5191	2
	5240	3
	5321	1
	5388	3
Average		78
Wm. Pollock Mill and Elevator Co., Mexico, Mo. Pure Wheat Bran	5199	1
The Rea-Patterson Milling Co., Coffeyville, Kan. Wheat Bran	2427	1
	2753	3
	3230	1
	3912	1
	3998	1
	4340	1
	4467	1
	4983	1
Average		10

BRANS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
15.38	15.43	4.13	3.27	53.20	54.63	10.72	9.72	9.42	7.15
16.31	15.43	4.18	3.27	52.40	54.63	10.09	9.72	10.62	6.40
16.00	15.43	4.45	3.27	53.38	54.63	8.78	9.72	11.23	6.16
14.87	15.43	3.97	3.27	52.45	54.63	9.60	9.72	12.40	6.71
15.13	15.43	3.71	3.27	53.70	54.63	9.82	9.72	10.98	6.66
15.25	15.43	4.16	3.27	52.14	54.63	9.77	9.72	12.00	6.68
16.97	15.43	4.65	3.27	52.64	54.63	8.56	9.72	10.97	6.21
15.69	15.43	4.52	3.27	53.86	54.63	9.12	9.72	10.65	6.16
15.00	15.43	3.96	3.27	53.37	54.63	9.30	9.72	11.80	6.57
15.94	15.43	4.65	3.27	54.67	54.63	8.89	9.72	9.83	6.02
16.38	15.43	4.74	3.27	54.61	54.63	8.03	9.72	10.32	5.92
15.13	15.43	4.45	3.27	54.52	54.63	8.73	9.72	10.91	6.26
16.00	15.43	4.51	3.27	53.88	54.63	8.27	9.72	11.43	5.91
15.13	15.43	4.25	3.27	53.21	54.63	10.12	9.72	10.52	6.77
15.73	15.43	4.36	3.27	53.96	54.63	9.49	9.72	10.29	6.77
15.31	15.43	4.29	3.27	53.72	54.63	9.62	9.72	10.15	6.91
15.19	15.43	4.13	3.27	53.20	54.63	9.25	9.72	11.95	6.28
15.56	15.43	4.40	3.27	53.10	54.63	8.94	9.72	11.37	6.63
14.94	15.43	4.33	3.27	54.24	54.63	8.98	9.72	11.02	6.49
16.06	15.43	4.44	3.27	55.32	54.63	7.90	9.72	10.53	5.75
14.81	15.43	3.43	3.27	51.53	54.63	8.21	9.72	15.32	6.70
15.44	15.43	4.50	3.27	54.45	54.63	8.13	9.72	11.17	6.31
14.75	15.43	4.19	3.27	53.59	54.63	9.43	9.72	11.98	6.06
16.25	15.43	3.84	3.27	54.33	54.63	7.88	9.72	10.84	6.86
15.37	15.43	5.35	3.27	52.02	54.63	9.65	9.72	10.48	7.13
15.67	15.43	4.31	3.27	53.29	54.63	9.04	9.72	11.26	6.43
14.25	13.00	4.18	3.50	53.66	36.00	9.07	9.00	11.77	7.07
16.94	14.52	3.76	3.29	53.38	55.96	9.71	8.50	10.35	5.86
16.19	14.52	3.33	3.29	55.32	55.96	8.65	8.50	11.02	5.49
16.75	14.52	3.44	3.29	52.19	55.96	9.32	8.50	12.15	6.15
16.25	14.52	3.70	3.29	54.83	55.96	8.64	8.50	10.64	5.94
16.31	14.52	3.76	3.29	53.56	55.96	9.06	8.50	10.90	6.41
14.25	14.52	3.63	3.29	55.25	55.96	8.70	8.50	11.54	6.63
15.88	14.52	3.64	3.29	56.27	55.96	9.52	8.50	9.14	5.55
16.00	14.52	3.95	3.29	54.39	55.96	9.86	8.50	9.42	6.38
16.07	14.52	3.65	3.29	54.40	55.96	9.18	8.50	10.65	6.05

WHEAT

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Reichert Milling Co., Freesburg, Ill.		
Wheat Bran..	2289	1
	2451	4
	2700	1
	2751	1
	2979	1
	4079	1
	4120	1
	4263	2
	4376	2
	4501	1
	4548	1
	5045	1
	5093	1
	5319	1
	5368	1
Average..		20
Russell Grain Co., Kansas City, Mo.		
Square Deal Bran..	2461	1
	2705	1
Average..		2
Sauers Milling Co., Evansville, Ill.		
Wheat Bran..	2440	2
	2579	1
Average..		3
Saxony Mills, St. Louis, Mo.		
Saxony Wheat Bran..	2222	4
	2571	2
	3545	1
	3799	1
	3975	3
	4050	1
	4601	1
	4690	1
	4806	1
	4946	1
Average..		16

BRANS.

PROTEIN		FAT		CARBOHY-DRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant,d %	Found %	Guarant'd %	Found %	Found %
15.94	11.05	5.05	2.00	54.92	45.00	7.76	15.00	10.61	5.72
15.63	11.05	4.68	2.00	55.71	45.00	7.99	15.00	10.33	5.66
15.88	11.05	4.50	2.00	54.19	45.00	8.10	15.00	11.68	5.65
15.75	11.05	4.37	2.00	55.01	45.00	7.93	15.00	11.39	5.55
15.75	11.05	4.79	2.00	54.59	45.00	7.76	15.00	11.12	5.99
16.35	11.05	4.86	2.00	53.19	45.00	8.23	15.00	11.44	5.93
15.56	11.05	4.53	2.00	55.19	45.00	9.34	15.00	8.75	6.63
15.56	11.05	4.58	2.00	56.03	45.00	8.12	15.00	9.81	5.90
15.10	11.05	4.61	2.00	55.45	45.00	8.28	15.00	10.47	6.19
15.88	11.05	4.90	2.00	54.97	45.00	8.56	15.00	9.75	5.94
15.94	11.05	5.06	2.00	53.85	45.00	8.50	15.00	10.03	6.62
15.50	11.05	5.18	2.00	54.90	45.00	8.95	15.00	9.13	6.34
16.31	11.05	4.81	2.00	52.55	45.00	8.16	15.00	11.54	6.63
12.13	11.05	2.99	2.00	55.05	45.00	13.38	15.00	10.27	6.18
15.25	11.05	4.57	2.00	56.18	45.00	8.22	15.00	9.27	6.51
15.50	11.05	4.63	2.00	54.78	45.00	8.62	15.00	10.37	6.11
16.81	14.20	4.08	4.90	52.44	54.80	9.39	9.70	10.86	6.42
16.06	14.20	4.37	4.90	50.23	54.80	10.54	9.70	11.74	7.06
16.44	14.20	4.22	4.90	51.34	54.80	9.96	9.70	11.30	6.74
17.06	14.26	3.95	3.21	50.89	55.18	11.09	8.80	10.00	7.01
15.69	14.26	4.30	3.21	53.41	55.18	8.74	8.80	11.71	6.15
16.37	14.26	4.13	3.21	52.15	55.18	9.92	8.80	10.85	6.58
15.69	12.00	4.66	3.00	54.13	52.00	8.13	10.00	11.53	5.86
15.91	12.00	4.41	3.00	54.19	52.00	8.56	10.00	11.32	5.61
16.06	12.00	4.60	3.00	53.14	52.00	8.23	10.00	11.50	6.47
16.00	12.00	4.48	3.00	54.10	52.00	8.34	10.00	10.91	6.17
15.94	12.00	4.66	3.00	54.49	52.00	8.17	10.00	10.85	5.89
15.56	12.00	4.14	3.00	56.62	52.00	8.03	10.00	10.20	5.45
15.75	12.00	4.38	3.00	56.89	52.00	8.20	10.00	8.64	6.14
15.81	12.00	4.35	3.00	56.88	52.00	8.35	10.00	8.78	5.83
15.88	12.00	4.78	3.00	57.05	52.00	8.45	10.00	7.89	5.95
15.94	12.00	4.38	3.00	55.69	52.00	7.47	10.00	10.60	5.92
15.85	12.00	4.49	3.00	55.32	52.00	8.19	10.00	10.22	5.93

WHEAT

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Scott County Milling Co., Sikeston and Oran, Mo.		
Wheat Bran	2453	6
	2574	2
	2916	1
	3046	1
	3591	1
	3695	2
	3817	2
	3976	2
	4089	1
	4160	2
	4259	1
	4359	5
	4587	2
	4661	1
	4674	2
	4738	1
	5107	3
	5178	1
	5211	3
	5332	11
	5386	1
	5454	1
Average		52
Slater Mill and Elevator Co., Slater, Mo.		
Wheat Bran	2434	2
	2624	1
	3376	1
	3461	1
	3691	1
	3945	1
	4246	2
	4470	1
	5189	2
	5260	1
	5462	1
Average		14
Southern Grain Co., Kansas City, Mo.		
Wheat Bran	2413	2
	2558	3
	2680	2
	3223	1

BRANS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
16.06	14.15	3.89	4.50	56.49	57.00	7.46	7.10	11.08	5.02
15.43	14.15	3.67	4.50	56.14	57.00	6.84	7.10	12.85	5.07
17.19	14.15	4.77	4.50	54.31	57.00	7.35	7.10	10.21	6.17
16.00	14.15	4.01	4.50	57.65	57.00	6.53	7.10	10.55	5.26
15.06	14.15	3.54	4.50	59.42	57.00	5.82	7.10	11.88	4.28
16.13	14.15	4.22	4.50	55.84	57.00	7.65	7.10	10.78	5.38
15.94	14.15	3.75	4.50	57.75	57.00	6.79	7.10	10.39	5.38
15.94	14.15	3.92	4.50	56.36	57.00	7.35	7.10	10.49	5.94
15.81	14.15	3.75	4.50	56.33	57.00	7.77	7.10	10.64	5.69
15.75	14.15	3.84	4.50	59.78	57.00	6.90	7.10	8.71	5.02
15.25	14.15	4.08	4.50	58.13	57.00	7.75	7.10	9.33	5.46
15.19	14.15	4.09	4.50	57.31	57.00	6.96	7.10	11.42	5.03
14.56	14.15	3.72	4.50	59.94	57.00	6.43	7.10	10.91	4.44
15.44	14.15	4.42	4.50	55.58	57.00	7.98	7.10	10.46	6.12
15.38	14.15	4.15	4.50	58.46	57.00	6.49	7.10	10.08	5.44
15.69	14.15	4.13	4.50	56.83	57.00	6.43	7.10	11.66	5.26
15.94	14.15	4.26	4.50	55.90	57.00	6.76	7.10	11.39	5.75
15.91	14.15	4.41	4.50	54.61	57.00	6.85	7.10	12.18	6.04
15.44	14.15	4.16	4.50	56.01	57.00	7.62	7.10	10.46	6.31
15.75	14.15	4.38	4.50	54.82	57.00	7.85	7.10	10.45	6.75
14.75	14.15	4.07	4.50	53.27	57.00	9.45	7.10	11.59	6.87
15.50	14.15	5.27	4.50	51.95	57.00	9.57	7.10	10.44	7.27
15.64	14.15	4.12	4.50	56.49	57.00	7.30	7.10	10.82	5.63
17.19	14.03	3.79	3.61	51.85	51.68	9.67	9.28	11.11	6.39
16.35	14.03	4.40	3.61	51.68	51.68	9.99	9.28	10.64	6.94
14.56	14.03	4.21	3.61	53.97	51.68	9.80	9.28	10.48	6.98
14.63	14.03	4.18	3.61	52.86	51.68	9.47	9.28	12.11	6.75
14.44	14.03	4.07	3.61	53.57	51.68	9.36	9.28	12.02	6.54
15.00	14.03	4.17	3.61	51.90	51.68	10.39	9.28	11.15	7.39
15.13	14.03	4.33	3.61	53.43	51.68	9.49	9.28	10.66	6.96
15.13	14.03	4.21	3.61	53.54	51.68	9.76	9.28	9.99	7.37
16.50	14.03	4.61	3.61	53.84	51.68	6.89	9.28	11.98	6.18
16.13	14.03	4.12	3.61	54.61	51.68	8.89	9.28	8.85	7.40
15.81	14.03	4.42	3.61	52.69	51.68	9.39	9.28	10.63	7.06
15.53	14.03	4.23	3.61	53.09	51.68	9.37	9.28	10.87	6.91
17.25	17.17	3.90	5.09	52.20	50.09	10.14	10.04	9.89	6.62
16.00	17.17	4.09	5.09	55.22	50.09	8.42	10.04	10.18	6.09
16.31	17.17	3.46	5.09	52.20	50.09	10.29	10.04	11.28	6.46
15.81	17.17	4.10	5.09	54.17	50.09	9.55	10.04	10.49	5.88

WHEAT

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Southern Grain Co.—Continued.		
	3697	5
	3869	1
	4349	2
	4540	1
	4695	1
	5153	2
	5255	1
Average		21
Southwestern Milling Co., Kansas City, Mo.		
K. C. K. Bran	3314	1
	4057	1
Average		2
Wheat Bran	2817	1
	3354	1
	3452	1
	3531	1
	3632	2
	4970	4
Average		10
Stanard-Tilton Milling Co., Dallas, Tex.		
Bran	2278	2
	2528	3
	2818	1
	3283	3
	3442	2
	3699	2
	3773	2
	4217	1
	4463	1
	4556	1
	4719	2
	4831	1
	5142	1
	5275	3
	5323	1
	5392	4
	5421	2
Average		32
Wheat Bran	5235	1

BRANS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
17.50	17.17	4.00	5.09	52.22	50.09	9.29	10.04	10.83	6.16
17.25	17.17	4.24	5.09	52.08	50.09	9.58	10.04	10.88	5.97
14.19	17.17	3.86	5.09	53.33	50.09	9.77	10.04	12.25	6.60
16.56	17.17	4.37	5.09	53.88	50.09	8.31	10.04	10.57	6.31
15.06	17.17	4.01	5.09	52.28	50.09	10.18	10.04	11.27	7.20
15.38	17.17	3.71	5.09	53.64	50.09	8.54	10.04	12.24	6.49
14.56	17.17	4.50	5.09	53.26	50.09	10.22	10.04	10.56	6.90
15.99	17.17	4.02	5.09	53.14	50.09	9.48	10.04	10.95	6.42
16.56	15.00	3.82	5.25	52.35	58.25	10.36	10.00	9.62	7.29
15.75	15.00	3.26	5.25	49.79	58.25	10.62	10.00	13.47	7.11
16.16	15.00	3.54	5.25	51.07	58.25	10.49	10.00	11.54	7.20
17.06	14.85	4.28	3.58	53.84	54.60	9.13	10.00	9.44	6.25
17.25	14.85	4.09	3.58	51.19	54.60	9.45	10.00	11.40	6.62
16.19	14.85	3.68	3.58	51.45	54.60	10.20	10.00	11.23	7.25
16.13	14.85	3.82	3.58	51.92	54.60	9.57	10.00	11.63	6.93
17.69	14.85	3.94	3.58	51.23	54.60	8.43	10.00	12.16	6.55
16.44	14.85	3.93	3.58	53.15	54.60	9.20	10.00	10.66	6.62
16.79	14.85	3.96	3.58	52.13	54.60	9.33	10.00	11.09	6.70
17.81	15.66	4.09	4.73	52.03	57.38	8.68	7.68	11.61	5.78
17.30	15.66	4.38	4.73	54.44	57.38	8.42	7.68	9.87	5.59
17.19	15.66	3.92	4.73	56.53	57.38	7.22	7.68	10.09	5.05
17.25	15.66	3.92	4.73	55.40	57.38	8.01	7.68	9.83	5.59
17.50	15.66	4.12	4.73	53.34	57.38	8.13	7.68	11.39	5.32
17.56	15.66	4.20	4.73	53.69	57.38	8.10	7.68	10.87	5.58
16.81	15.66	4.44	4.73	54.85	57.38	7.68	7.68	10.25	5.97
16.56	15.66	4.09	4.73	54.67	57.38	8.08	7.68	10.77	5.83
17.88	15.66	4.57	4.73	55.52	57.38	7.85	7.68	8.91	5.27
15.75	15.66	3.37	4.73	51.04	57.38	11.99	7.68	10.41	7.44
16.69	15.66	4.67	4.73	55.06	57.38	7.66	7.68	10.79	5.13
17.06	15.66	4.57	4.73	55.12	57.38	8.16	7.68	9.42	5.67
15.38	15.66	4.56	4.73	55.69	57.38	7.69	7.68	11.26	5.42
16.69	15.66	4.00	4.73	52.67	57.38	8.95	7.68	10.59	7.10
17.31	15.66	4.48	4.73	53.85	57.38	7.74	7.68	10.43	6.19
17.88	15.66	4.35	4.73	53.41	57.38	7.85	7.68	10.34	6.17
18.31	15.66	4.64	4.73	53.49	57.38	7.52	7.68	10.07	5.97
17.11	15.66	4.26	4.73	54.16	57.38	8.22	7.68	10.41	5.84
17.63	16.80	4.28	4.70	56.82	54.15	7.23	8.00	8.52	5.52

WHEAT

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Steelville Milling Co., Steelville, Ill.		
Steelville Bran	3197	1
	3739	6
	4163	2
	4903	1
	5184	1
	5216	3
	5300	1
	5446	3
Average		18
St. Mary's Mill Co., St. Mary's, Mo.		
Soft Winter Wheat Bran	2220	3
	2264	3
	2502	13
	2628	6
	2726	2
	2793	2
	2917	1
	2960	2
	3165	6
	3276	2
	3381	5
	3429	3
	3740	2
	3790	2
	3816	3
	3983	2
	4083	2
	4101	5
	4183	1
	4283	2
	4398	1
	4473	1
	4534	2
	4591	3
	4696	1
	4723	1
	4837	2
	4875	1
	2388	5
	5033	3
	5195	1
	5208	2

BRANS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
15.50	14.50	4.64	3.50	53.86	50.00	8.13	10.00	11.79	6.08
15.38	14.50	4.70	3.50	55.86	50.00	7.94	10.00	10.27	5.85
15.69	14.50	4.47	3.50	56.28	50.00	8.45	10.00	9.15	5.96
15.19	14.50	4.88	3.50	56.91	50.00	8.25	10.00	8.66	6.11
14.31	14.50	4.64	3.50	53.26	50.00	7.59	10.00	12.86	7.34
16.50	14.50	4.22	3.50	53.02	50.00	8.71	10.00	11.32	6.23
15.25	14.50	4.90	3.50	55.98	50.00	9.06	10.00	7.97	6.84
14.94	14.50	4.16	3.50	54.59	50.00	8.82	10.00	11.01	6.48
15.35	14.50	4.58	3.50	54.97	50.00	8.37	10.00	10.37	6.36
16.19	15.06	4.30	3.06	53.24	54.70	8.30	8.93	11.46	6.51
16.38	15.06	4.37	3.06	53.63	54.70	8.57	8.93	10.99	6.06
16.61	15.06	4.32	3.06	53.74	54.70	7.97	8.93	11.68	5.68
16.50	15.06	4.54	3.06	54.61	54.70	7.59	8.93	11.30	5.46
16.51	15.06	4.51	3.06	53.75	54.70	7.69	8.93	11.46	6.08
16.81	15.06	4.19	3.06	56.03	54.70	7.69	8.93	9.36	5.92
16.81	15.06	4.97	3.06	53.54	54.70	7.70	8.93	10.65	6.33
16.56	15.06	4.56	3.06	55.58	54.70	7.44	8.93	10.17	5.69
16.69	15.06	4.75	3.06	53.59	54.70	8.06	8.93	10.92	5.99
17.06	15.06	4.41	3.06	54.24	54.70	8.60	8.93	9.65	6.04
16.56	15.06	4.72	3.06	54.08	54.70	8.24	8.93	10.29	6.11
16.31	15.06	4.52	3.06	55.20	54.70	8.45	8.93	9.53	5.99
16.69	15.06	4.33	3.06	54.24	54.70	8.39	8.93	10.33	6.02
16.88	15.06	4.52	3.06	54.30	54.70	9.45	8.93	8.89	5.96
16.25	15.06	4.24	3.06	54.40	54.70	8.37	8.93	10.40	6.34
16.13	15.06	4.30	3.06	54.92	54.70	8.50	8.93	10.30	5.85
15.88	15.06	4.35	3.06	54.80	54.70	8.13	8.93	10.89	5.95
16.38	15.06	4.50	3.06	55.14	54.70	8.21	8.93	9.62	6.15
16.00	15.06	4.41	3.06	54.85	54.70	8.24	8.93	10.32	6.18
16.06	15.06	4.62	3.06	55.80	54.70	9.24	8.93	9.34	5.94
15.69	15.06	4.11	3.06	54.19	54.70	8.04	8.93	11.75	6.22
16.06	15.06	4.56	3.06	55.69	54.70	8.36	8.93	8.85	6.48
15.56	15.06	4.28	3.06	56.36	54.70	7.69	8.93	10.19	5.92
15.75	15.06	4.48	3.06	56.03	54.70	7.85	8.93	9.62	6.27
16.00	15.06	4.48	3.06	55.09	54.70	8.31	8.93	9.84	6.28
16.06	15.06	4.40	3.06	55.69	54.70	8.08	8.93	9.76	6.01
16.44	15.06	4.54	3.06	53.96	54.70	8.13	8.93	10.58	6.35
15.88	15.06	4.39	3.06	54.74	54.70	7.76	8.93	11.15	6.08
16.44	15.06	4.43	3.06	52.79	54.70	8.30	8.93	11.95	6.09
15.69	15.06	4.42	3.06	55.42	54.70	8.26	8.93	9.77	6.44
16.25	15.06	4.66	3.06	52.72	54.70	7.17	8.93	11.47	7.73
15.62	15.06	4.40	3.06	53.85	54.70	7.89	8.93	11.86	6.38

WHEAT

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
St. Mary's Mill Co.—Continued.		
	5277	2
	5327	5
	5398	1
	5440	5
	5073	2
Average		105
Texas Star Flour Mills, Galveston, Tex.		
Wheat Bran	2260	5
	2402	2
	2674	6
	2754	2
	3018	1
	3312	1
	3443	2
	3577	2
	3721	1
	3839	2
	3934	2
	4002	1
	4273	1
	4472	1
	4627	2
	4746	1
	5182	1
	5267	2
Average		35
A. Waller and Co., Corydon, Ky.		
Wheat Bran	5056	1
Washington Flour Mill Co., Washington, Mo.		
Bran	2723	1
Waterloo Mill Co., Waterloo, Ill.		
Wheat Bran	3196	1
	3602	1
Average		2

BRANS.

PROTEIN		FAT		CARBOHY-DRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
15.00	15.06	4.20	3.06	55.14	54.70	8.10	8.93	11.02	6.54
15.38	15.06	4.36	3.06	55.15	54.70	8.72	8.93	10.02	6.37
18.50	15.06	4.25	3.06	58.47	54.70	3.52	8.93	11.22	4.04
15.56	15.06	4.53	3.06	54.06	54.70	9.00	8.93	10.10	6.75
15.56	15.06	4.43	3.06	52.43	54.70	8.16	8.93	12.53	6.89
——	——	——	——	——	——	——	——	——	——
16.23	15.06	4.44	3.06	54.63	54.70	8.05	8.93	10.52	6.13
17.43	14.50	4.28	3.75	54.07	54.16	8.11	8.45	10.65	5.46
18.19	14.50	4.20	3.75	55.11	54.16	7.85	8.45	9.46	5.19
17.68	14.50	4.47	3.75	52.43	54.16	7.63	8.45	12.20	5.59
17.63	14.50	4.07	3.75	53.34	54.16	7.88	8.45	11.31	5.77
17.19	14.50	4.17	3.75	53.84	54.16	7.63	8.45	11.35	5.82
17.13	14.50	4.13	3.75	54.90	54.16	7.72	8.45	10.83	5.29
17.37	14.50	3.71	3.75	53.98	54.16	7.89	8.45	11.47	5.58
17.69	14.50	4.15	3.75	53.28	54.16	8.84	8.45	10.18	5.86
17.06	14.50	4.09	3.75	55.81	54.16	7.19	8.45	10.55	5.30
17.56	14.50	4.17	3.75	52.16	54.16	8.55	8.45	11.67	5.89
18.06	14.50	3.98	3.75	54.52	54.16	7.45	8.45	10.54	5.45
18.06	14.50	3.99	3.75	54.35	54.16	8.57	8.45	9.42	5.61
18.19	14.50	4.09	3.75	54.46	54.16	8.05	8.45	9.64	5.57
17.56	14.50	4.17	3.75	55.98	54.16	7.48	8.45	9.44	5.37
17.31	14.50	4.12	3.75	53.01	54.16	8.13	8.45	11.35	6.08
17.00	14.50	4.16	3.75	54.23	54.16	7.98	8.45	11.32	5.31
17.00	14.50	4.28	3.75	51.43	54.16	7.98	8.45	12.37	6.94
16.88	14.50	4.10	3.75	54.00	54.16	8.29	8.45	10.09	6.64
——	——	——	——	——	——	——	——	——	——
17.50	14.50	4.13	3.75	53.94	54.16	7.95	8.45	10.77	5.71
15.94	14.50	3.97	4.00	57.88	55.00	6.12	8.00	11.11	4.98
15.57	14.80	4.55	3.97	50.94	52.83	8.69	9.00	13.87	6.38
16.38	15.00	4.45	4.00	53.45	54.00	8.13	8.25	11.38	6.21
16.13	15.00	4.84	4.00	53.49	54.00	8.83	8.25	9.72	6.99
——	——	——	——	——	——	——	——	——	——
16.26	15.00	4.64	4.00	53.47	54.00	8.48	8.25	10.55	6.60

WHEAT

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Western Star Milling Co., Salina, Kan.		
Wheat Bran	2506	3
	2915	1
	2981	1
Average		5
Wheat Bran	2227	3
	2403	2
	3065	2
	3454	1
	3603	1
Average		9
Star Winter Wheat Bran	4848	1
	4937	1
Average		2
Winnfield Roller Mills, Winnfield, Kan.		
Wheat Bran	2351	1
	2547	1
	3306	1
	5402	1
Average		4
Yukon Mill and Grain Co., Yukon, Okla.		
Bran	4177	1
Zenith Milling Co., Kansas City, Mo.		
Bran in unbranded sacks, marked "B"	2390	3
	2539	5
	2691	3
	4676	2
Average		13

BRANS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
19.13	12.50	4.01	2.75	50.13	51.60	8.86	12.00	11.48	6.39
18.81	12.50	4.12	2.75	50.67	51.60	9.60	12.00	10.34	6.41
18.69	12.50	3.98	2.75	50.27	51.60	9.33	12.00	10.68	7.05
—	—	—	—	—	—	—	—	—	—
18.88	12.50	4.04	2.75	50.36	51.60	9.27	12.00	10.83	6.62
18.31	14.85	4.16	3.58	51.91	54.60	8.91	10.00	10.27	6.44
18.81	14.85	4.08	3.58	50.83	54.60	9.95	10.00	9.69	6.64
18.50	14.85	3.85	3.58	49.82	54.60	9.56	10.00	11.58	6.69
18.25	14.85	4.01	3.58	51.16	54.60	9.83	10.00	10.19	6.56
17.88	14.85	4.41	3.58	51.41	54.60	9.38	10.00	10.48	6.44
—	—	—	—	—	—	—	—	—	—
18.35	14.85	4.10	3.58	51.03	54.60	9.53	10.00	10.44	6.55
17.75	14.00	4.03	3.00	52.99	53.00	8.65		10.23	6.35
17.90	14.00	4.31	3.00	53.53	53.00	9.10		8.85	6.31
—	—	—	—	—	—	—	—	—	—
17.83	14.00	4.17	3.00	53.26	53.00	8.87		9.54	6.33
16.69	14.00	3.63	4.20	53.67	55.00	8.62	7.93	12.06	5.33
16.19	14.00	3.77	4.20	53.72	55.00	8.84	7.93	11.74	5.74
16.31	14.00	3.67	4.20	53.62	55.00	9.03	7.93	11.69	5.68
15.56	14.00	3.99	4.20	54.07	55.00	9.67	7.93	10.52	6.22
—	—	—	—	—	—	—	—	—	—
16.19	14.00	3.76	4.20	53.77	55.00	9.04	7.93	11.50	5.74
16.38	17.36	3.93	4.35	57.87	51.74	6.75	9.23	11.10	3.97
15.94	14.05	4.48	5.05	51.72	50.04	9.69	13.05	11.50	6.67
16.04	14.05	4.91	5.05	53.48	50.04	8.35	13.05	11.26	5.96
15.91	14.05	4.64	5.05	53.04	50.04	8.58	13.05	11.62	6.21
14.31	14.05	3.95	5.05	53.59	50.04	10.03	13.05	11.11	7.01
—	—	—	—	—	—	—	—	—	—
15.55	14.05	4.50	5.05	52.96	50.04	9.16	13.05	11.37	6.46

WHEAT

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Atchison Live Stock Co., Atchison, Kan.		
Wheat Shorts	2656	1
	2893	1
	3252	1
	3387	1
	3486	1
	3674	1
Average		6
Aulne Milling Co., Aulne, Kan.		
Wheat Shorts	2372	1
Aurora Milling Co., Aurora, Mo.		
Cream Wheat Shorts	3048	1
Jarrett Wheat Shorts	2458	1
	2653	1
	2662	1
	3045	1
	4252	1
Average		5
Marcus Bernheimer Flour Mills Co., St. Louis and Clinton, Missouri.		
Banner Middlings	4486	1
	4825	1
Average		2
Blair Milling Co., Atchison, Kan.		
Blair's Shorts	2438	3
	2676	3
	2775	1
	2963	3
	3061	1
	3242	2
	3345	2
	3584	1
	3911	1
	4187	1

SHORTS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
19.88	10.50	5.17	1.50	55.03	41.00	6.00	19.50	9.05	4.87
19.38	10.50	5.16	1.50	54.53	41.00	5.39	19.50	10.86	4.68
17.13	10.50	3.97	1.50	55.75	41.00	6.31	19.50	12.16	4.68
18.31	10.50	4.08	1.50	60.32	41.00	4.59	19.50	8.78	3.92
18.00	10.50	4.34	1.50	56.51	41.00	4.85	19.50	12.29	4.01
17.56	10.50	4.05	1.50	59.52	41.00	4.76	19.50	10.44	3.67
18.38	10.50	4.66	1.50	56.94	41.00	5.03	19.50	10.69	4.30
18.00	14.90	4.68	4.50	55.94	56.80	5.84	7.40	11.28	4.26
17.75	15.00	4.08	3.60	57.04	60.00	6.42	4.90	10.46	4.25
17.56	16.00	3.88	3.13	50.50	53.00	10.08	9.00	11.55	6.43
15.31	16.00	4.46	3.13	52.86	53.00	9.35	9.00	12.55	5.47
17.19	16.00	5.04	3.13	59.16	53.00	4.91	9.00	10.32	3.38
14.69	16.00	4.19	3.13	53.96	53.00	9.76	9.00	10.57	6.83
15.94	16.00	4.32	3.13	55.30	53.00	9.64	9.00	8.87	6.03
16.14	16.00	4.37	3.13	54.36	53.00	8.74	9.00	10.77	5.62
16.63	15.00	4.47	4.00	61.50	55.00	2.85	5.00	11.44	3.11
19.88	15.00	5.08	4.00	53.21	55.00	7.04	5.00	9.58	5.21
18.26	15.00	4.78	4.00	57.35	55.00	4.94	5.00	10.51	4.16
17.31	14.50	4.41	3.50	57.83	56.00	6.27	9.00	9.76	4.42
17.13	14.50	3.90	3.50	56.85	56.00	6.08	9.00	11.66	4.38
18.39	14.50	4.89	3.50	54.75	56.00	6.06	9.00	11.28	4.63
17.19	14.50	3.66	3.50	57.90	56.00	6.32	9.00	10.36	4.57
18.31	14.50	4.22	3.50	58.47	56.00	5.32	9.00	9.65	4.03
17.63	14.50	4.42	3.50	56.73	56.00	5.97	9.00	10.77	4.48
18.06	14.50	4.67	3.50	55.88	56.00	5.90	9.00	11.09	4.40
19.13	14.50	4.18	3.50	57.51	56.00	4.67	9.00	10.13	4.38
18.69	14.50	4.47	3.50	56.31	56.00	5.64	9.00	10.21	4.68
16.88	14.50	4.63	3.50	56.31	56.00	6.05	9.00	11.68	4.45

WHEAT

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Blair Milling Co.—Continued.		
	4460	2
	4767	1
	5174	1
	5380	1
	5415	1
Average		24
Cain Mill Co., Atchison, Kan.		
Cain's Shorts	3351	1
	3484	1
	3583	1
	3710	1
	4251	1
	4331	1
	4448	2
	4828	1
	4938	1
	4995	1
	5119	1
	5228	1
	5381	1
Average		14
Caldwell Milling Co., Caldwell, Kan.		
Wheat Shorts	5431	1
Carbondale Mill and Elevator Co., Carbondale, Ill.		
Shipstuff	2463	1
	4200	1
	5185	2
Average		4
Davis Milling Co., St. Joseph Mo.		
Pure Wheat Shorts	2583	1
	3017	1
	4142	1
	4276	1

SHORTS.

PROTEIN		FAT		CARBOHY-DRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
16.94	14.50	5.28	3.50	58.98	56.00	4.79	9.00	9.99	4.02
16.31	14.50	4.42	3.50	55.77	56.00	7.02	9.00	11.53	4.95
17.00	14.50	4.78	3.50	58.75	56.00	5.14	9.00	9.90	4.43
17.56	14.50	4.56	3.50	58.38	56.00	5.45	9.00	9.83	4.22
18.44	14.50	4.42	3.50	57.61	56.00	3.75	9.00	11.91	3.87
——	——	——	——	——	——	——	——	——	——
17.66	14.50	4.46	3.50	57.21	56.00	5.63	9.00	10.65	4.39
16.81	14.75	5.08	4.25	60.38	58.00	5.39	6.00	8.48	3.86
19.13	14.75	4.49	4.25	55.45	58.00	5.64	6.00	10.66	4.63
17.06	14.75	4.48	4.25	58.51	58.00	5.71	6.00	9.83	4.41
18.88	14.75	4.18	4.25	56.01	58.00	5.12	6.00	11.48	4.33
17.75	14.75	4.72	4.25	58.47	58.00	5.74	6.00	8.81	4.51
18.94	14.75	3.97	4.25	57.40	58.00	5.82	6.00	8.98	4.89
16.13	14.75	4.50	4.25	59.29	58.00	5.73	6.00	10.00	4.35
17.00	14.75	4.12	4.25	59.25	58.00	5.20	6.00	10.30	4.13
16.38	14.75	4.24	4.25	61.17	58.00	5.29	6.00	9.09	3.83
16.44	14.75	4.53	4.25	60.39	58.00	5.46	6.00	9.15	4.03
14.13	14.75	4.25	4.25	55.64	58.00	8.80	6.00	10.72	6.46
16.50	14.75	4.51	4.25	58.38	58.00	5.38	6.00	10.81	4.42
15.81	14.75	4.43	4.25	59.43	58.00	5.65	6.00	10.28	4.40
——	——	——	——	——	——	——	——	——	——
17.00	14.75	4.42	4.25	58.45	58.00	5.76	6.00	9.89	4.48
17.06	16.39	3.75	3.58	62.49	59.84	4.39	4.29	8.60	3.71
17.06	16.20	4.12	3.90	56.30	60.30	6.83	4.15	11.03	4.66
17.06	16.20	4.47	3.90	55.84	60.30	6.36	4.15	11.74	4.53
16.13	16.20	4.62	3.90	56.79	60.30	6.02	4.15	10.91	5.53
——	——	——	——	——	——	——	——	——	——
16.75	16.20	4.40	3.90	56.31	60.30	6.40	4.15	11.23	4.91
16.29	13.00	4.34	4.00	56.68	55.00	6.57	5.00	11.10	5.02
16.00	13.00	4.39	4.00	59.75	55.00	5.45	5.00	10.02	4.39
15.31	13.00	4.30	4.00	58.65	55.00	6.28	5.00	10.54	4.92
15.56	13.00	4.51	4.00	60.03	55.00	5.50	5.00	9.94	4.46

WHEAT

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Davis Milling Co.—Continued.		
	5164	1
	5432	1
Average		6
Enid Mill and Elevator Co., Enid, Okla.		
Wheat Shorts (mostly flour)	4468	1
R. H. Faucett Mill Co., St. Joseph, Mo.		
Wheat Shorts	2362	2
	2566	2
	3177	1
	3266	2
	4776	1
	4827	1
Average		9
Garvin Flour and Grain Co., Wichita, Kan.		
Wheat Shorts	3064	1
	3372	1
	3866	1
Average		3
Higginsville Milling Co., Higginsville, Mo.		
Shipstuff or Shorts	2517	1
	2892	1
	3035	2
	3222	1
	3352	1
	3533	1
	3627	1
	3802	1
	3947	1
	4257	1
	4289	1
	4320	1
	4395	1
	5031	2
	5259	1
	5369	1
Average		18

SHORTS.

PROTEIN		FAT		CARBOHY-DRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
16.06	13.00	4.54	4.00	59.34	55.00	5.29	5.00	9.48	5.29
18.25	13.00	4.48	4.00	56.66	55.00	6.62	5.00	8.90	5.09
—	—	—	—	—	—	—	—	—	—
16.25	13.00	4.43	4.00	58.52	55.00	5.95	5.00	9.99	4.86
14.00	19.90	1.37	4.40	72.88	58.40	0.65	4.59	10.72	0.88
17.43	17.15	4.33	4.76	57.65	56.67	5.57	8.06	10.74	4.28
16.92	17.15	4.90	4.76	58.13	56.67	4.95	8.06	11.14	3.96
18.32	17.15	5.31	4.76	55.74	56.67	4.53	8.06	11.68	4.42
17.56	17.15	4.91	4.76	57.61	56.67	4.94	8.06	10.66	4.32
17.06	17.15	4.35	4.76	55.96	56.67	7.17	8.06	10.51	4.95
16.06	17.15	4.55	4.76	59.88	56.67	5.05	8.06	10.16	4.30
—	—	—	—	—	—	—	—	—	—
17.23	17.15	4.73	4.76	57.49	56.67	5.37	8.06	10.82	4.37
18.25	14.90	4.82	4.50	57.00	56.00	5.74	7.40	9.98	4.21
20.94	14.90	4.70	4.50	54.35	56.00	5.75	7.40	9.03	5.23
19.38	14.90	4.16	4.50	56.99	56.00	4.80	7.40	10.42	4.25
—	—	—	—	—	—	—	—	—	—
19.52	14.90	4.56	4.50	56.12	56.00	5.43	7.40	9.81	4.56
16.38	18.30	4.96	4.87	59.64	59.68	5.55	4.50	9.27	4.20
18.96	18.30	5.77	4.87	55.94	59.68	5.52	4.50	9.15	4.66
16.63	18.30	3.99	4.87	59.09	59.68	5.80	4.50	10.22	4.27
17.00	18.30	4.50	4.87	56.52	59.68	6.35	4.50	11.10	4.53
17.13	18.30	4.15	4.87	55.89	59.68	7.07	4.50	11.18	4.58
17.13	18.30	4.80	4.87	56.66	59.68	6.09	4.50	10.93	4.39
16.75	18.30	4.48	4.87	56.65	59.68	5.92	4.50	11.82	4.38
17.31	18.30	4.40	4.87	57.96	59.68	6.13	4.50	10.12	4.08
16.31	18.30	4.68	4.87	58.10	59.68	5.90	4.50	10.50	4.51
16.50	18.30	4.89	4.87	58.42	59.68	5.86	4.50	9.65	4.68
16.50	18.30	5.03	4.87	58.05	59.68	6.72	4.50	8.88	4.82
16.19	18.30	4.58	4.87	58.98	59.68	5.89	4.50	9.96	4.40
16.19	18.30	4.92	4.87	59.16	59.68	5.68	4.50	9.49	4.56
16.31	18.30	4.48	4.87	58.01	59.68	6.52	4.50	9.94	4.74
18.56	18.30	4.09	4.87	56.85	59.68	5.63	4.50	9.38	5.49
18.59	18.30	5.21	4.87	57.43	59.68	4.75	4.50	9.74	4.28
—	—	—	—	—	—	—	—	—	—
17.03	18.30	4.68	4.87	57.71	59.68	5.96	4.50	10.08	4.54

WHEAT

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Hunter Bros. Milling Co., St. Louis, Mo. Pure Wheat Shorts	4147	1
Inmann Manufacturing Co., Inmann, Kan. Wheat Shorts	5061	1
Kelly Milling Co., Kansas City, Mo. Wheat Shorts	3023	1
Kelly Lysle Milling Co., Leavenworth, Kan. Pure Wheat Shorts	2415	3
	2586	1
	2679	2
	2896	1
	2969	1
	3076	2
	3440	2
	3655	1
	3841	2
	3895	2
	4138	2
	4293	1
	4667	2
	4884	1
	5038	2
	5225	1
	5270	2
	5382	1
	5444	2
Average		31
Land Milling Co., Neodesha, Kan. Wheat Shorts	2464	1
The Leavenworth Milling Co., Leavenworth, Kan. Pure Wheat Shorts	2303	2
	2444	2
	2677	3
	2797	2

SHORTS.

PROTEIN		FAT		CARBOHY-DRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
18.81	16.00	5.11	4.00	54.34	56.00	5.30	10.00	11.93	4.51
17.94		4.45		59.19		4.55		10.00	3.87
15.94	14.90	3.71	4.50	57.56	56.80	6.56	7.40	11.44	4.79
18.06	14.50	5.20	4.50	56.24	54.00	6.00	8.00	10.03	4.47
16.93	14.50	3.90	4.50	56.77	54.00	6.70	8.00	11.31	4.39
18.25	14.50	5.52	4.50	55.78	54.00	5.42	8.00	10.69	4.34
18.88	14.50	5.66	4.50	55.45	54.00	5.71	8.00	9.61	4.69
21.75	14.50	5.08	4.50	51.90	54.00	6.29	8.00	10.22	4.76
17.94	14.50	5.45	4.50	55.31	54.00	6.28	8.00	10.30	4.72
16.81	14.50	5.03	4.50	56.96	54.00	5.72	8.00	10.68	4.80
17.81	14.50	5.30	4.50	55.42	54.00	6.80	8.00	9.91	4.76
18.06	14.50	5.43	4.50	54.52	54.00	6.09	8.00	11.05	4.85
17.50	14.50	4.70	4.50	57.46	54.00	5.74	8.00	9.91	4.69
18.00	14.50	5.36	4.50	55.10	54.00	6.28	8.00	10.37	4.89
19.75	14.50	5.38	4.50	54.10	54.00	6.33	8.00	8.87	5.57
17.38	14.50	5.32	4.50	56.49	54.00	6.32	8.00	9.65	4.84
17.75	14.50	4.85	4.50	56.69	54.00	5.34	8.00	11.08	4.29
17.25	14.50	4.93	4.50	57.96	54.00	5.85	8.00	9.04	4.97
18.00	14.50	4.72	4.50	58.46	54.00	4.91	8.00	9.53	4.38
18.50	14.50	4.94	4.50	56.79	54.00	5.16	8.00	9.99	4.62
16.12	14.50	3.80	4.50	58.76	54.00	6.32	8.00	10.14	4.86
19.44	14.50	5.20	4.50	54.81	54.00	5.45	8.00	10.23	4.87
18.11	14.50	5.04	4.50	56.05	54.00	5.93	8.00	10.14	4.74
17.25	15.26	3.94	3.92	56.70	60.08	6.40	5.02	11.27	4.44
18.88	14.04	4.66	4.60	54.71	56.04	6.54	7.04	10.69	4.52
17.37	14.04	4.37	4.60	57.40	56.04	6.48	7.04	10.00	4.38
18.06	14.04	4.60	4.60	55.37	56.04	6.31	7.04	10.99	4.67
17.81	14.04	4.41	4.60	56.61	56.04	6.46	7.04	10.12	4.59

WHEAT

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
The Leavenworth Milling Co.—Continued.		
	2996	1
	3318	1
	3492	1
	3587	1
	3688	1
	3801	1
	4216	1
	4531	2
	4732	1
	4822	1
	4842	1
	4921	2
	4988	1
	5232	1
	5293	1
Average		26
Lukens Milling Co., Atchison, Kan. Wheat Shorts	2647	1
	3047	1
	3134	1
	3238	2
	3683	1
	3994	1
	4043	1
	4260	1
	4565	1
	4689	1
Average		14
Majestic Milling Co., Aurora, Mo. Wheat Shorts	2477	2
McEwen Grain Co., Kansas City, Mo. Wheat Shorts	2338	1
Missouri and Kansas Grain Co., Neosho, Mo. Pure Wheat Shorts	4645	1

SHORTS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd	Found %	Found %
18.00	14.04	4.56	4.60	55.38	56.04	6.28	7.04	11.16	4.62
17.50	14.04	4.29	4.60	57.96	56.04	5.76	7.04	10.42	4.07
17.63	14.04	4.41	4.60	55.21	56.04	6.42	7.04	11.41	4.92
17.69	14.04	3.96	4.60	55.95	56.04	6.43	7.04	11.05	4.92
17.63	14.04	4.31	4.60	54.65	56.04	7.27	7.04	11.02	5.12
17.69	14.04	4.37	4.60	56.25	56.04	6.25	7.04	10.78	4.66
15.88	14.04	4.63	4.60	57.63	56.04	6.47	7.04	10.67	4.72
16.44	14.04	4.73	4.60	57.37	56.04	6.04	7.04	10.80	4.62
16.56	14.04	4.63	4.60	57.80	56.04	5.95	7.04	10.75	4.31
16.31	14.04	4.58	4.60	58.83	56.04	5.93	7.04	10.03	4.32
16.75	14.04	4.60	4.60	57.91	56.04	6.50	7.04	9.85	4.39
16.63	14.04	4.42	4.60	57.63	56.04	6.13	7.04	10.65	4.54
16.13	14.04	4.76	4.60	59.37	56.04	5.79	7.04	9.88	4.07
16.56	14.04	4.15	4.60	59.29	56.04	4.56	7.04	11.23	4.21
17.13	14.04	4.69	4.60	57.79	56.04	6.56	7.04	9.07	4.76
17.19	14.04	4.48	4.60	57.01	56.04	6.21	7.04	10.56	4.55
17.31	13.00	4.78	4.00	57.92	55.00	5.33	9.00	10.65	4.01
18.19	13.00	4.63	4.00	54.65	55.00	7.27	9.00	10.14	5.12
17.38	13.00	4.36	4.00	55.54	55.00	6.70	9.00	11.18	4.84
17.75	13.00	4.23	4.00	53.96	55.00	7.40	9.00	11.21	5.45
18.19	13.00	4.36	4.00	53.59	55.00	7.41	9.00	10.64	5.81
16.81	13.00	4.49	4.00	58.39	55.00	6.17	9.00	9.63	4.51
17.00	13.00	4.45	4.00	58.35	55.00	6.36	9.00	9.51	4.33
18.19	13.00	4.71	4.00	56.50	55.00	6.32	9.00	9.71	4.57
15.81	13.00	4.34	4.00	59.50	55.00	5.69	9.00	10.45	4.21
16.50	13.00	4.70	4.00	58.96	55.00	5.82	9.00	9.62	4.40
17.31	13.00	4.51	4.00	56.74	55.00	6.45	9.00	10.27	4.72
18.19	15.00	5.27	3.75	56.37	60.00	5.58	3.50	10.85	3.70
19.25	14.00	5.45	5.05	56.72	64.08	3.89	5.00	10.82	3.87
19.44	15.00	4.38	3.50	54.84	52.00	5.56	8.00	10.69	5.09

WHEAT

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Neosho Milling Co., Neosho, Mo.		
Wheat Shorts	2592	1
	3901	1
Average		2
Oklahoma City Mill and Elevator Co., Oklahoma City, Okla.		
Wheat Shorts	4575	1
	4602	1
	4881	1
	4928	1
	4974	2
	5198	1
	5241	3
	5474	1
Average		11
Geo. P. Plant Milling Co., St. Louis, Mo.		
"P. Middlings"	3865	1
The Rea-Patterson Milling Co., Coffeyville, Kan.		
Wheat Shorts	4338	1
	4733	1
Average		2
Sauers Milling Co., Evansville, Ill.		
Wheat Shipstuff	2474	5
Scott County Milling Co., Sikeston and Oran, Mo.		
Wheat Middlings	5179	1
	5404	1
Average		2
Slater Mill and Elevator Co., Slater, Mo.		
Wheat Shorts	2433	2
	2618	1

SHORTS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
17.06	15.00	4.65	3.50	58.35	52.00	5.91	8.00	10.14	3.89
20.06	15.00	4.70	3.50	54.10	52.00	6.44	8.00	9.58	5.12
18.56	15.00	4.68	3.50	56.22	52.00	6.18	8.00	9.86	4.50
15.88	14.75	4.66	4.25	56.39	58.00	6.83	6.00	11.22	5.02
16.19	14.75	4.70	4.25	56.36	58.00	6.91	6.00	11.02	4.82
16.50	14.75	3.87	4.25	54.66	58.00	7.14	6.00	12.77	5.06
17.19	14.75	3.86	4.25	54.85	58.00	6.75	6.00	12.16	5.19
16.50	14.75	3.60	4.25	56.43	58.00	7.02	6.00	11.49	4.96
16.38	14.75	4.65	4.25	54.12	58.00	5.90	6.00	11.96	6.99
17.31	14.75	3.27	4.25	56.19	58.00	5.21	6.00	12.69	5.33
17.16	14.75	4.71	4.25	57.05	58.00	6.35	6.00	9.96	4.77
16.64	14.75	4.16	4.25	55.76	58.00	6.51	6.00	11.66	5.27
17.81	17.11	5.09	4.41	56.25	59.11	5.32	5.18	11.07	4.46
19.81	15.22	4.80	3.94	55.34	61.02	4.99	4.25	10.28	4.78
18.25	15.22	4.16	3.94	60.91	61.02	3.20	4.25	10.25	3.23
19.03	15.22	4.48	3.94	58.13	61.02	4.09	4.25	10.27	4.00
16.63	14.96	5.02	4.20	58.57	60.10	5.14	4.92	10.36	4.18
16.50	16.27	4.65	5.90	56.15	61.60	6.09	3.45	11.45	5.16
20.31	16.27	7.05	5.90	50.92	61.60	5.95	3.45	10.08	5.69
18.41	16.27	5.85	5.90	53.53	61.60	6.02	3.45	10.77	5.42
17.13	15.36	4.04	4.55	56.99	56.39	6.71	5.28	10.71	4.42
17.25	15.36	3.96	4.55	57.14	56.39	6.46	5.28	10.94	4.25

WHEAT

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Slater Mill and Elevator Co.—Continued.	3353	1
	3617	1
	3946	1
	4245	2
	4487	1
	5155	1
	5188	2
	5256	1
	5455	1
Average		14
Southern Grain Co., Kansas City, Mo.		
Wheat Shorts	2646	2
	3681	1
	3870	1
	4682	1
	5166	1
Average		6
Southwestern Milling Co., Kansas City, Mo.		
K. C. K. Shorts	3310	1
	5365	1
Average		2
Wheat Shorts	4481	1
Stanard Tilton Milling Co., Dallas, Tex.		
Wheat Shorts	3767	1
Steelville Milling Co., Steelville, Ill.		
Steelville Middlings	3176	1
Washington Flour Mill Co., Washington, Mo.		
Shipstuff or Shorts	2724	1

SHORTS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
17.31	15.36	4.22	4.55	56.28	56.39	6.69	5.28	11.09	4.41
16.06	15.36	4.57	4.55	57.18	56.39	5.92	5.28	11.56	4.71
16.69	15.36	4.73	4.55	57.04	56.39	6.19	5.28	10.46	4.89
16.94	15.36	4.43	4.55	57.41	56.39	5.90	5.28	10.68	4.64
16.06	15.36	4.31	4.55	58.26	56.39	5.51	5.28	11.00	4.86
18.75	15.36	3.83	4.55	57.00	56.39	5.04	5.28	10.65	4.73
16.19	15.36	4.66	4.55	56.29	56.39	6.16	5.28	11.74	4.96
15.81	15.36	4.32	4.55	59.55	56.39	5.46	5.28	10.17	4.69
18.19	15.36	4.77	4.55	57.44	56.39	5.47	5.28	9.36	4.77
16.94	15.36	4.35	4.55	57.33	56.39	5.95	5.28	10.76	4.67
20.38	17.07	4.81	5.07	52.24	50.09	5.62	10.04	11.93	5.02
16.50	17.07	3.43	5.07	59.72	50.09	5.25	10.04	11.61	3.49
16.75	17.07	3.26	5.07	59.64	50.09	5.31	10.04	11.70	3.34
18.00	17.07	5.53	5.07	55.15	50.09	6.66	10.04	9.88	4.78
17.69	17.07	5.07	5.07	56.39	50.09	5.44	10.04	9.97	5.44
17.86	17.07	4.42	5.07	56.63	50.09	5.66	10.04	11.02	4.41
19.25	15.50	4.83	5.25	51.81	61.25	7.66	6.25	10.89	5.56
18.88	15.50	5.39	5.25	54.30	61.25	7.22	6.25	8.43	5.78
19.06	15.50	5.11	5.25	53.06	61.25	7.44	6.25	9.66	5.67
19.59	14.90	4.54	4.50	53.89	56.80	7.02	7.40	9.38	5.58
18.00	20.19	3.93	4.20	62.39	56.25	2.89	7.40	9.66	3.13
15.38	15.00	4.17	4.00	62.01	55.00	3.24	5.00	12.32	2.88
16.19	16.95	4.36	5.48	61.11	58.14	3.36	3.97	11.64	3.34

WHEAT

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Western Star Milling Co., Salina, Kan.		
Star Winter Wheat Middlings	4930	1
Winnfield Roller Mills, Winnfield, Kan.		
Wheat Shorts	2422	1
	2548	1
	3309	1
	5250	1
	5406	1
Average		5

WHEAT

Pearl Roller Mills, Oswego, Kan.		
Mixed Feed (bran and shorts)	4055	1
	4244	2
	2385	2
Average		5
The Rea-Patterson Milling Co., Coffeyville, Kan.		
Mixed Feed (bran and shorts)	3430	4
	3696	2
	3984	3
	4049	1
	4306	4
	4507	3
	4768	1
	4804	2
	5190	3
	5424	2
Average		25

WHEAT FEEDS

Anchor Roller Mills, Fort Worth, Texas.		
Wheat and Corn Bran Mixed	4343	1
	5318	2
	5361	1
	5411	1
Average		5

SHORTS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
17.69	16.00	3.94	3.00	52.37	55.00	8.93		10.72	6.35
18.06	15.00	4.46	4.00	57.60	55.00	5.54	8.58	10.42	3.92
18.24	15.00	3.93	4.00	53.63	55.00	9.07	8.58	10.75	4.34
18.38	15.00	4.49	4.00	56.34	55.00	5.04	8.58	11.84	3.91
16.94	15.00	3.88	4.00	60.45	55.00	4.48	8.58	10.62	3.63
17.31	15.00	3.97	4.00	61.29	55.00	3.85	8.58	9.88	3.70
——	——	——	——	——	——	——	——	——	——
17.79	15.00	4.15	4.00	57.86	55.00	5.60	8.58	10.70	3.90

MIXED FEEDS.

16.56	13.19	3.74	3.77	56.28	62.57	6.64	5.22	12.24	4.54
16.56	13.19	3.72	3.77	56.81	62.57	7.23	5.22	10.45	5.23
17.69	13.19	3.79	3.77	55.88	62.57	6.07	5.22	12.17	4.40
——	——	——	——	——	——	——	——	——	——
16.94	13.19	3.75	3.77	56.32	62.57	6.65	5.22	11.62	4.72
17.06	14.52	3.83	3.50	55.04	57.33	7.96	7.90	10.68	5.43
16.88	14.52	4.00	3.50	56.41	57.33	7.41	7.90	10.23	5.07
16.38	14.52	3.95	3.50	53.10	57.33	9.26	7.90	11.24	6.07
16.25	14.52	3.87	3.50	57.65	57.33	6.85	7.90	10.42	4.96
16.19	14.52	4.89	3.50	52.94	57.33	9.20	7.90	10.28	6.50
16.00	14.52	4.04	3.50	56.18	57.33	7.07	7.90	11.59	5.12
15.94	14.52	4.10	3.50	57.97	57.33	7.26	7.90	9.57	5.16
16.25	14.52	4.17	3.50	58.55	57.33	7.61	7.90	8.12	5.30
16.13	14.52	3.91	3.50	54.98	57.33	7.81	7.90	11.17	6.00
16.63	14.52	3.68	3.50	58.32	57.33	6.85	7.90	9.06	5.46
——	——	——	——	——	——	——	——	——	——
16.37	14.52	4.04	3.50	56.13	57.33	7.73	7.90	10.23	5.50

WITH ADMIXTURES.

15.88	18.10	3.93	3.80	59.37	56.90	6.51	7.10	9.48	4.83
15.13	18.10	3.65	3.80	60.71	56.90	5.73	7.10	10.06	4.72
18.35	18.10	3.65	3.80	55.53	56.90	7.37	7.10	10.14	4.96
17.84	18.10	4.22	3.80	55.10	56.90	7.02	7.10	10.99	4.83
——	——	——	——	——	——	——	——	——	——
16.80	18.10	3.86	3.80	57.68	56.90	6.66	7.10	10.17	4.83

WHEAT FEEDS

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Arkadelphia Roller Mills, Arkadelphia, Ark.		
Mixed Bran	4145	1
	4312	1
	4552	1
Average		3
Blair Milling Co., Atchison, Kan.		
Blair's Shorts and Corn Hearts	4332	1
Buck and O'Toole Milling Co., Bloomfield, Mo.		
Mixed Bran	3063	1
Capital Grain and Mill Co., Nashville, Tenn.		
Capital Feed (wheat product, corn and ground corn cobs)	4019	3
	4080	1
	4139	2
	4239	8
	4346	2
	4550	1
	4609	2
Average		20
Mixed Bran Feed (wheat product, corn and ground corn cobs)	3580	2
	3633	2
	3694	7
	3777	4
	3871	1
	3977	6
	4093	2
	4483	1
Average		25
Tennesse Dairy Feed (wheat product, corn and ground corn cobs)	4732	1
	5042	1
Average		2

WITH ADMIXTURES.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
13.69	18.75	3.50	3.69	51.15	54.78	13.31	7.37	10.58	7.77
13.88	18.75	4.62	3.69	53.15	54.78	11.18	7.37	10.45	6.72
13.25	18.75	3.53	3.69	59.07	54.78	8.60	7.37	9.92	5.63
—	—	—	—	—	—	—	—	—	—
13.61	18.75	3.88	3.69	54.44	54.78	11.03	7.37	10.32	6.72
14.87	16.00	5.23	4.00	62.46	59.00	3.79	6.00	9.92	3.73
15.50	12.00	3.97	4.00	55.72	53.00	7.91	12.00	11.41	5.49
8.75	10.25	2.55	3.00	57.43	55.00	18.03	13.50	9.85	3.39
7.50	10.25	2.07	3.00	55.40	55.00	21.11	13.50	10.35	3.57
8.31	10.25	2.05	3.00	54.45	55.00	21.34	13.50	9.82	4.03
9.12	10.25	2.79	3.00	62.37	55.00	12.68	13.50	9.74	3.30
9.75	10.25	2.85	3.00	61.04	55.00	10.98	13.50	11.77	3.61
8.50	10.25	2.29	3.00	55.63	55.00	20.37	13.50	9.13	4.08
9.50	10.25	2.65	3.00	54.36	55.00	18.50	13.50	10.55	4.44
—	—	—	—	—	—	—	—	—	—
8.78	10.25	2.46	3.00	57.24	55.00	17.57	13.50	10.17	3.78
8.88	13.42	2.43	3.80	56.27	56.00	18.77	11.24	9.97	3.68
9.06	13.42	2.34	3.80	55.39	56.00	17.86	11.24	11.57	3.78
8.56	13.42	1.86	3.80	53.39	56.00	22.27	11.24	10.27	3.65
9.13	13.42	2.16	3.80	54.44	56.00	20.34	11.24	9.66	4.27
9.25	13.42	2.18	3.80	52.60	56.00	19.88	11.24	11.97	4.12
8.81	13.42	2.14	3.80	56.78	56.00	18.61	11.24	10.41	3.25
9.00	13.42	2.11	3.80	56.35	56.00	19.06	11.24	9.83	3.65
8.31	13.42	2.21	3.80	58.50	56.00	18.36	11.24	9.53	3.09
—	—	—	—	—	—	—	—	—	—
8.88	13.42	2.18	3.80	55.46	56.00	19.39	11.24	10.40	3.69
12.31	11.50	3.49	3.00	60.19	55.00	11.31	12.25	9.83	2.87
8.69	11.50	2.13	3.00	55.75	55.00	19.05	12.25	9.94	4.44
—	—	—	—	—	—	—	—	—	—
10.50	11.50	2.81	3.00	57.97	55.00	15.18	12.25	9.89	3.65

WHEAT FEEDS

Name of Manufacturer or Jobber and Brand.	Station Number	Number of samples composited
Charleston Milling Co., Charleston, Mo.		
Mixed Bran (wheat and corn)	2909	2
	3313	1
	3904	1
	3995	1
	4248	1
	5126	2
	5338	3
	5445	3
Average		14
Cunningham Commission Co., Little Rock, Ark.		
Mixed Mill Feed (contains oat hulls)	3482	1
	3521	2
	3932	2
	4108	2
	4284	1
	4342	1
	4657	1
	4668	2
	4769	1
	4803	1
	4838	2
	4914	2
	4988	1
	5160	1
	5247	2
	5320	1
	5453	1
Average		24
S. C. Lemar, Rich Hill, Mo.		
Bran Feed	2294	1
	2452	4
	2750	1
	2860	1
	2907	2
	3109	3
	3270	2
	3378	1
	3780	1
Average		16

WITH ADMIXTURES.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
15.75	17.31	4.51	4.90	52.87	51.42	8.75	8.17	11.24	6.88
15.00	17.31	4.96	4.90	55.92	51.42	9.12	8.17	9.03	5.97
14.31	17.31	5.21	4.90	56.90	51.42	8.92	8.17	9.19	5.47
13.63	17.31	4.85	4.90	57.30	51.42	8.11	8.17	11.13	4.98
14.81	17.31	4.57	4.90	57.14	51.42	8.52	8.17	9.10	5.86
13.81	17.31	4.69	4.90	55.30	51.42	7.45	8.17	12.47	6.28
15.88	17.31	4.59	4.90	55.31	51.42	8.49	8.17	8.92	6.81
15.19	17.31	4.51	4.90	53.71	51.42	8.92	8.17	11.36	6.31
14.80	17.31	4.73	4.90	55.56	51.42	8.54	8.17	10.30	6.07
13.88	13.80	5.49	4.50	48.89	52.00	12.40	11.00	11.26	8.08
11.44	13.80	4.47	4.50	45.41	52.00	18.90	11.00	9.75	10.03
13.88	13.80	5.43	4.50	53.58	52.00	9.79	11.00	10.48	6.84
14.44	13.80	4.24	4.50	46.31	52.00	13.80	11.00	12.32	8.89
14.00	13.80	3.53	4.50	53.36	52.00	13.43	11.00	7.85	7.83
12.69	13.80	4.03	4.50	48.20	52.00	15.51	11.00	9.89	9.68
13.81	13.80	3.84	4.50	49.15	52.00	12.96	11.00	11.70	8.54
14.19	13.80	3.39	4.50	44.99	52.00	18.06	11.00	9.74	9.63
11.75	13.80	2.34	4.50	41.51	52.00	23.72	11.00	9.15	11.53
11.63	13.80	2.51	4.50	42.99	52.00	23.30	11.00	7.76	11.81
14.19	13.80	3.96	4.50	47.03	52.00	15.66	11.00	9.90	9.26
12.00	13.80	3.01	4.50	46.87	52.00	17.37	11.00	10.81	9.94
12.31	13.80	3.53	4.50	47.28	52.00	17.59	11.00	9.11	10.18
13.44	13.80	3.33	4.50	51.46	52.00	13.34	11.00	10.16	8.27
15.44	13.80	5.17	4.50	56.03	52.00	6.67	11.00	11.24	5.45
16.06	13.80	3.91	4.50	50.63	52.00	11.25	11.00	10.67	7.48
10.88	13.80	3.45	4.50	63.17	52.00	9.72	11.00	9.01	3.77
13.30	13.80	3.86	4.50	49.23	52.00	14.91	11.00	10.04	8.66
13.50	11.30	4.10	3.40	55.08	61.96	10.41	9.37	10.30	6.61
13.50	11.30	3.59	3.40	57.77	61.96	8.95	9.37	10.87	5.32
12.00	11.30	3.78	3.40	57.48	61.96	9.67	9.37	11.23	5.84
11.56	11.30	3.74	3.40	56.92	61.96	10.07	9.37	11.90	5.81
12.43	11.30	3.70	3.40	53.70	61.96	12.47	9.37	10.53	7.17
11.81	11.30	3.26	3.40	57.13	61.96	9.56	9.37	12.55	5.69
14.69	11.30	3.06	3.40	55.42	61.96	9.78	9.37	10.93	6.12
14.00	11.30	3.82	3.40	53.07	61.96	11.16	9.37	11.03	6.92
15.44	11.30	3.60	3.40	54.16	61.96	10.54	9.37	9.63	6.63
13.21	11.30	3.63	3.40	55.64	61.96	10.29	9.37	11.00	6.23

WHEAT FEEDS

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Josey Miller Co., Beaumont, Tex.		
Bran (contains oat hulls)	2242	2
	2599	1
Average		3
Mixed Bran	2831	2
	2920	1
	3685	1
	3908	1
	3936	2
	4608	2
	5234	1
Average		10
Mound City Manufacturing Co., Mound City, Ill.		
Wheat Bran	4869	1
Sweetsprings Milling Co., Sweetsprings, Mo.		
Wheat Bran	2657	1
	5162	1
Average		2
A. Waller and Co., Henderson, Ky.		
Blue Grass Mixed Feed (wheat products and ground corn cobs)	3193	1
Yates and Donelson Co., Memphis, Tenn.		
Mixed Bran (wheat bran and corn bran)	2295	1
	2498	2
	2612	3
	2990	1
	3189	1
	3316	1
	3560	2
	3723	3
	3811	2
	3867	1
	3997	1
	4081	3

WITH ADMIXTURES.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
11.73	12.59	3.89	3.91	46.36	51.33	17.79	12.78	9.76	10.47
12.37	12.59	3.36	3.91	48.17	51.33	17.07	12.78	9.93	9.10
12.05	12.59	3.63	3.91	47.26	51.33	17.43	12.78	9.85	9.78
10.75	12.00	3.60	3.40	45.34	51.00	18.84	12.00	11.38	10.09
11.88	12.00	3.67	3.40	48.12	51.00	16.51	12.00	10.71	9.11
12.37	12.00	3.52	3.40	46.81	51.00	16.47	12.00	10.82	10.01
17.31	12.00	4.29	3.40	53.81	51.00	7.87	12.00	10.93	5.79
12.44	12.00	3.11	3.40	45.73	51.00	18.59	12.00	10.26	9.87
10.81	12.00	3.53	3.40	46.50	51.00	18.17	12.00	10.82	10.17
11.75	12.00	3.32	3.40	57.05	51.00	10.06	12.00	8.48	9.34
12.47	12.00	3.58	3.40	49.05	51.00	15.22	12.00	10.48	9.20
12.75	14.50	5.31	4.00	58.53	55.00	8.04	9.50	10.34	5.03
13.88	13.57	4.16	2.63	53.90	53.99	9.41	11.84	11.98	6.67
13.44	13.57	4.35	2.63	53.84	53.99	10.01	11.84	11.29	7.07
13.66	13.57	4.26	2.63	53.87	53.99	9.71	11.84	11.63	6.87
10.50	10.00	2.94	2.50	55.60	55.00	15.77	18.00	11.74	3.45
14.13	13.25	4.27	3.70	58.02	57.15	7.56	10.00	10.44	5.58
14.75	13.25	4.64	3.70	57.13	57.15	7.78	10.00	10.94	4.76
15.44	13.25	4.37	3.70	58.19	57.15	7.65	10.00	9.46	4.89
14.56	13.25	4.57	3.70	55.85	57.15	8.10	10.00	12.00	4.92
16.60	13.25	4.78	3.70	52.72	57.15	8.06	10.00	11.95	5.89
14.93	13.25	4.74	3.70	57.11	57.15	8.43	10.00	9.23	5.56
14.63	13.25	4.97	3.70	55.96	57.15	8.45	10.00	10.60	5.39
13.75	13.25	5.06	3.70	58.32	57.15	7.93	10.00	10.27	4.67
14.81	13.25	4.67	3.70	56.45	57.15	7.97	10.00	11.11	4.99
15.19	13.25	4.40	3.70	57.54	57.15	7.62	10.00	9.92	5.33
13.50	13.25	4.50	3.70	57.29	57.15	7.89	10.00	10.95	5.87
14.06	13.25	4.66	3.70	58.38	57.15	7.78	10.00	10.16	4.96

WHEAT FEEDS

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Yates and Donelson Co.—Continued.		
	4221	1
	4500	1
	5089	1
	5139	1
	5322	1
	5467	1
Average		27

MOLASSES

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Alfalfa Product Co., Fremont, Neb.		
Alfalfa Lass (alfalfa and molasses)	3041	1
	3355	1
Average		2
American Milling Co., Owensboro, Ky.		
Sucrene Dairy Feed (corn, oats, barley, cotton seed meal, distillery products, molasses and weed seeds)	2219	3
	2345	3
	2516	1
	2748	1
	3398	2
	3550	1
	3708	1
	3836	2
	4092	1
	4274	1
	4421	1
	4632	1
	4823	1
	4899	1
	4917	2
	5069	1
	5106	3
	5197	1
	5223	1
	5304	1
	5348	2
	5387	1
Average		32

WITH ADMIXTURES.

PROTEIN		FAT		CARBOHY-DRATES		FIBER		WATER	ASH
Found %	Guarant'd	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
13.88	13.25	4.84	3.70	59.20	57.15	7.21	10.00	10.27	4.60
14.50	13.25	4.18	3.70	58.80	57.15	7.91	10.00	9.85	4.76
13.81	13.25	4.21	3.70	57.19	57.15	8.38	10.00	11.64	4.77
13.56	13.25	4.05	3.70	57.86	57.15	7.66	10.00	11.86	5.01
15.13	13.25	3.85	3.70	56.20	57.15	7.68	10.00	10.70	6.44
18.06	13.25	4.53	3.70	55.57	57.15	6.89	10.00	9.83	5.12
14.74	13.25	4.52	3.70	57.10	57.15	7.83	10.00	10.62	5.19

FEEDS.

11.75	14.00	0.94	2.00	42.85	44.00	16.73	20.00	18.75	8.98
11.56	14.00	1.15	2.00	48.01	44.00	13.22	20.00	16.57	9.49
11.66	14.00	1.04	2.00	45.43	44.00	14.98	20.00	17.66	9.23

16.56	16.50	4.87	3.50	48.42	48.27	10.90	12.00	12.05	7.20
17.63	16.50	5.82	3.50	47.44	48.27	11.63	12.00	10.21	7.27
17.43	16.50	4.81	3.50	46.00	48.27	10.49	12.00	14.40	6.87
16.75	16.50	4.61	3.50	46.30	48.27	11.97	12.00	12.50	7.87
15.56	16.50	4.66	3.50	50.14	48.27	12.20	12.00	10.78	6.66
17.06	16.50	5.34	3.50	46.44	48.27	13.16	12.00	11.66	6.34
17.94	16.50	5.84	3.50	43.73	48.27	14.22	12.00	11.40	6.87
17.50	16.50	5.78	3.50	44.43	48.27	14.45	12.00	11.55	6.29
17.25	16.50	5.28	3.50	47.04	48.27	13.79	12.00	10.37	6.27
17.69	16.50	4.98	3.50	46.91	48.27	13.06	12.00	11.00	6.36
18.44	16.50	5.04	3.50	47.87	48.27	11.45	12.00	10.44	6.76
17.75	16.50	5.03	3.50	46.87	48.27	12.48	12.00	11.41	6.46
15.00	16.50	4.45	3.50	52.88	48.27	10.34	12.00	11.30	6.03
17.88	16.50	5.09	3.50	47.11	48.27	11.62	12.00	11.29	7.01
16.81	16.50	4.83	3.50	47.90	48.27	11.17	12.00	12.83	6.46
17.25	16.50	5.06	3.50	46.00	48.27	12.13	12.00	13.08	6.48
16.50	16.50	4.75	3.50	46.17	48.27	10.61	12.00	14.26	7.71
16.38	16.50	4.74	3.50	47.69	48.27	10.94	12.00	13.26	6.99
17.63	16.50	4.71	3.50	46.13	48.27	11.05	12.00	11.37	9.11
16.81	16.50	6.56	3.50	43.51	48.27	10.56	12.00	14.23	8.33
17.00	16.50	4.32	3.50	47.64	48.27	12.55	12.00	10.62	7.87
18.00	16.50	5.33	3.50	44.63	48.27	10.07	12.00	13.27	8.70
17.13	16.50	5.09	3.50	46.87	48.27	11.86	12.00	11.97	7.08

MOLASSES

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
American Milling Co., Owensboro, Ky., and Philadelphia, Pa. Sucrene Horse, Mule and Ox Feed (distillery products, corn products, oat hulls, cotton seed meal, molasses and weed seeds)......................................	3982	2
	4335	1
	4423	1
	4462	1
	4631	1
	4692	1
	4728	1
	4794	3
	4868	1
	4351	2
	5034	4
	4982	1
	4729	1
	2225	3
	2339	3
	2617	1
	3395	2
	3601	1
	3709	1
	3792	2
	3818	3
	4091	1
	4900	1
	4915	2
	5077	2
	5161	1
	5186	2
	5231	1
	5312	2
	5356	3
	5464	1
Average..		52
Lawrence and Hamilton, New Orleans, La. Stafolife (corn, rice product, cotton seed meal and molasses. Many of the shipments were fortified with brewers' grains and alfalfa........	2212	23
	2261	8
	2410	12
	2509	7
	2614	11

FEEDS.

PROTEIN		FAT		CARBOHY-DRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
11.69	10.00	5.14	3.00	52.21	52.45	14.11	13.50	11.65	5.20
11.38	10.00	3.87	3.00	53.03	52.45	13.96	13.50	12.80	4.96
11.25	10.00	3.69	3.00	58.13	52.45	10.43	13.50	11.01	5.49
12.00	10.00	3.83	3.00	57.59	52.45	10.27	13.50	11.08	5.23
12.00	10.00	3.35	3.00	56.35	52.45	10.85	13.50	11.88	5.57
11.44	10.00	3.15	3.00	60.67	52.45	8.88	13.50	10.94	4.92
11.75	10.00	3.40	3.00	60.58	52.45	9.32	13.50	10.31	4.64
11.06	10.00	3.13	3.50	60.63	52.45	8.66	13.50	11.19	5.33
11.50	10.00	3.04	3.00	58.75	52.45	8.84	13.50	12.43	5.44
11.75	10.00	3.03	3.00	55.96	52.45	10.55	13.50	13.32	5.39
11.25	10.00	3.07	3.00	59.96	52.45	8.58	13.50	11.90	5.24
11.69	10.00	3.26	3.00	58.97	52.45	9.55	13.50	11.59	4.94
11.75	10.00	3.18	3.00	59.48	52.45	9.28	13.50	11.13	5.18
12.63	10.00	4.51	3.00	53.87	52.45	10.05	13.50	12.25	6.69
13.06	10.00	4.32	3.00	54.41	52.45	10.01	13.50	10.48	6.82
13.05	10.00	4.14	3.00	53.04	52.45	10.34	13.50	13.03	6.40
14.44	10.00	4.39	3.00	51.19	52.45	11.61	13.50	11.81	6.56
11.56	10.00	4.01	3.00	52.46	52.45	12.36	13.50	13.16	6.45
11.75	10.00	4.56	3.00	53.03	52.45	12.89	13.50	11.99	5.78
12.00	10.00	4.58	3.00	53.39	52.45	13.81	13.50	10.86	5.36
11.38	10.00	4.07	3.00	54.69	52.45	12.61	13.50	11.02	6.23
12.06	10.00	3.79	3.00	55.05	52.45	12.62	13.50	10.77	5.71
11.31	10.00	3.41	3.00	59.35	52.45	8.77	13.50	11.55	5.61
10.88	10.00	3.23	3.00	58.98	52.45	8.27	13.50	13.24	5.40
11.25	10.00	3.46	3.00	57.75	52.45	9.17	13.50	13.33	5.04
10.75	10.00	3.45	3.00	59.01	52.45	8.90	13.50	11.90	5.99
10.75	10.00	3.42	3.00	58.44	52.45	8.92	13.50	13.09	5.38
11.13	10.00	3.34	3.00	60.28	52.45	9.25	13.50	10.50	5.50
11.56	10.00	3.68	3.00	55.52	52.45	8.38	13.50	13.95	6.91
12.00	10.00	3.46	3.00	56.55	52.45	7.85	13.50	13.42	6.72
9.94	10.00	3.62	3.00	57.56	52.45	9.21	13.50	13.49	6.18
11.68	10.00	3.70	3.00	56.67	52.45	10.29	13.50	11.97	5.69
10.94	11.00	5.96	6.00	52.13	53.00	10.57	11.00	11.70	8.70
11.50	11.00	5.66	6.00	52.50	53.00	11.15	11.00	10.80	8.39
11.94	11.00	5.90	6.00	53.93	53.00	10.72	11.00	9.15	8.36
11.75	11.00	6.09	6.00	51.17	53.00	11.06	11.00	11.70	8.23
12.09	11.00	6.97	6.00	50.03	53.00	10.90	11.00	11.22	8.79

MOLASSES

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Lawrence and Hamilton—Continued.		
	2692	4
	2733	5
	2790	4
	2880	14
	3040	4
	3068	5
	3102	11
	3151	6
	3215	6
	3263	6
	3331	8
	3436	5
	3525	6
	3575	6
	3651	10
	3741	15
	3814	7
	3819	13
	3897	9
	3925	7
	3971	12
	4103	16
	4210	6
	4232	10
	4281	5
	4357	12
	4403	5
	4494	10
	4566	17
	4582	4
	4615	8
	4666	3
	4716	22
	4790	11
	4854	10
	4913	13
	4975	7
	5064	1
	5078	4
	5215	2
	5265	2
	5340	4
Average..		396

FEEDS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
10.94	11.00	5.93	6.00	51.07	53.00	11.87	11.00	11.18	9.01
10.83	11.00	6.07	6.00	50.56	53.00	12.19	11.00	10.86	9.49
11.78	11.00	7.29	6.00	52.65	53.00	8.90	11.00	10.74	8.64
12.25	11.00	6.81	6.00	51.32	53.00	10.03	11.00	11.05	8.54
10.69	11.00	6.64	6.00	54.10	53.00	9.11	11.00	11.02	8 44
10.50	11.00	5.76	6.00	49.20	53.00	12.52	11.00	12.90	9.12
9.13	11.00	5.06	6.00	50.02	53.00	12.15	11.00	14.68	8.96
9.50	11.00	5.90	6.00	50.83	53.00	12.07	11.00	12.47	9.23
11.19	11.00	7.34	6.00	52.96	53.00	8.86	11.00	11.38	8 27
11.13	11.00	5.93	6.00	50.71	53.00	11.50	11.00	12.40	8.33
12.06	11.00	6.21	6.00	49.85	53.00	10.49	11.00	13.10	8.29
12.19	11.00	6.39	6.00	52.89	53.00	8.85	11.00	11.93	7.75
12.31	11.00	5.97	6.00	49.08	53.00	11.20	11.00	12.36	9.08
12.00	11.00	6.75	6.00	50.92	53.00	9.32	11.00	12.61	8.40
11.25	11.00	6.68	6.00	52.29	53.00	8.80	11.00	13.72	7.26
12.37	11.00	5.21	6.00	52.74	53.00	10.11	11.00	11.11	8.46
11.50	11.00	5.42	6.00	53.39	53.00	9.42	11.00	12.67	7.60
11.25	11.00	5.25	6.00	53.45	53.00	10.10	11.00	11.33	8.62
11.06	11.00	5.26	6.00	53.83	53.00	11.18	11.00	10.49	8.18
11.56	11.00	6.30	6.00	52.79	53.00	10.87	11.00	10.81	7.67
11.56	11.00	6.28	6.00	53.37	53.00	9.76	11.00	11.41	7.62
13.44	11.00	6.57	6.00	53.61	53.00	9.99	11.00	9.38	7.01
14.50	11.00	6.66	6.00	51.49	53.00	9.00	11.00	11.10	7.25
14.06	11.00	6.06	6.00	50.15	53.00	12.11	11.00	9.04	8.[illegible]
12.69	11.00	5.80	6.00	55.23	53.00	9.12	11.00	9.72	7.44
12.00	11.00	6.50	6.00	51.52	53.00	10.32	11.00	11.31	8.35
13.81	11.00	7.18	6.00	48.86	53.00	11.06	11.00	10.64	8.45
12.31	11.00	6.73	6.00	51.90	53.00	11.09	11.00	9.45	8.52
12.94	11.00	5.63	6.00	50.80	53.00	12.40	11.00	9.77	8.46
11.75	11.00	4.77	6.00	52.16	53.00	12.99	11.00	9.81	8.52
12.44	11.00	5.76	6.00	49.14	53.00	13.35	11.00	9.98	9.33
11.81	11.00	5.86	6.00	49.66	53.00	15.19	11.00	8.91	8.57
11.56	11.00	5.82	6.00	50.48	53.00	14.02	11.00	8.82	9.30
14.13	11.00	5.01	6.00	48.66	53.00	14.73	11.00	8.96	8.51
13.57	11.00	4.62	6.00	48.71	53.00	15.23	11.00	10.67	7.20
12.81	11.00	4.48	6.00	51.15	53.00	13.62	11.00	10.78	7.16
13.38	11.00	4.44	6.00	52.28	53.00	12.30	11.00	10.24	7.36
12.75	11.00	6.72	6.00	49.44	53.00	11.63	11.00	12.74	6.72
12.69	11.00	4.18	6.00	50.72	53.00	12.52	11.00	12.27	7.62
12.94	11.00	4.45	6.00	55.21	53.00	10.97	11.00	11.27	5.16
11.31	11.00	5.17	6.00	58.04	53.00	9.01	11.00	10.49	5.98
11.13	11.00	5.47	6.00	56.54	53.00	9.88	11.00	9.36	7.52
11.98	11.00	5.89	6.00	51.79	53.00	11.15	11.00	11.05	8.14

	MOLASSES	
Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Nutriline Feed and Oil Co., Crowley, La.		
Nutriline Stock Feed	2206	22
	2347	7
	2454	7
	2605	10
	2711	4
	2736	8
	2829	7
	2947	11
	3004	6
	3067	14
	3100	12
	3217	15
	3325	11
	3380	14
	3432	6
	3472	14
	3554	9
	3616	9
	3670	9
	3742	8
	3791	8
	3837	4
	3896	5
	3959	5
	4032	12
	4106	5
	4211	12
	4234	6
	4361	6
	*4404	5
	*4438	11
	*4513	18
	*4583	11
	*4715	10
	*4789	4
	*4892	10
	*4940	1
	*5006	4
	*5076	8
	*5110	5
	*5214	4
	*5268	2
	*5337	10
	*5394	4
	*5428	5
Average		378

---

*These samples contain alfalfa, corn, wheat bran and molasses in varying proportions. The shipments previous to these were made up of cotton seed meal, rice products, corn and molasses.

FEEDS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
13.31	12.00	8.39	2.00	54.49	58.00	7.07	10.00	10.40	6.34
12.25	12.00	8.65	2.00	56.13	58.00	7.57	10.00	8.94	6.46
12.43	12.00	8.25	2.00	55.61	58.00	7.44	10.00	9.95	6.32
13.81	12.00	8.59	2.00	54.45	58.00	6.96	10.00	9.94	6.25
12.75	12.00	9.14	2.00	51.13	58.00	9.23	10.00	11.13	6.62
12.88	12.00	8.67	2.00	52.63	58.00	8.11	10.00	11.18	6.53
12.69	12.00	8.45	2.00	52.14	58.00	8.43	10.00	11.53	6.76
11.44	12.00	7.36	2.00	54.32	58.00	8.95	10.00	10.82	7.11
12.38	12.00	6.64	2.00	56.57	58.00	7.53	10.00	11.18	5.70
12.63	12.00	7.54	2.00	54.34	58.00	7.95	10.00	11.39	6.15
12.06	12.00	6.59	2.00	55.81	58.00	7.68	10.00	11.84	6.02
12.31	12.00	6.63	2.00	56.56	58.00	7.57	10.00	10.77	6.16
11.84	12.00	7.98	2.00	58.10	58.00	6.31	10.00	10.48	5.29
11.75	12.00	7.09	2.00	58.77	58.00	6.56	10.00	10.35	5.48
11.56	12.00	6.65	2.00	58.01	58.00	7.11	10.00	10.73	5.94
11.60	12.00	6.37	2.00	57.31	58.00	7.08	10.00	11.83	5.81
11.69	12.00	6.64	2.00	56.76	58.00	7.68	10.00	11.20	6.03
12.37	12.00	6.82	2.00	58.05	58.00	6.78	10.00	10.22	5.67
12.63	12.00	6.14	2.00	57.17	58.00	7.11	10.00	11.18	5.77
12.19	12.00	5.85	2.00	56.92	58.00	8.36	10.00	10.31	6.37
11.69	12.00	5.94	2.00	59.63	58.00	7.62	10.00	10.36	4.76
12.56	12.00	6.01	2.00	56.37	58.00	8.54	10.00	11.09	5.43
11.19	12.00	5.50	2.00	59.41	58.00	7.25	10.00	10.28	6.37
12.00	12.00	6.20	2.00	57.60	58.00	7.48	10.00	10.68	6.04
11.56	12.00	6.21	2.00	58.24	58.00	7.46	10.00	10.91	5.62
11.00	12.00	5.73	2.00	60.18	58.00	7.12	10.00	10.03	5.94
10.81	12.00	5.75	2.00	59.13	58.00	7.47	10.00	10.87	5.97
11.50	12.00	5.42	2.00	60.52	58.00	7.94	10.00	8.89	5.73
12.63	12.00	5.63	2.00	57.62	58.00	7.01	10.00	11.70	5.41
12.06	12.00	4.22	2.00	61.91	58.00	6.07	10.00	11.63	4.11
10.75	12.00	4.72	2.00	62.17	58.00	6.01	10.00	11.49	4.86
12.06	12.00	4.00	2.00	62.13	58.00	6.51	10.00	11.19	4.11
11.63	12.00	4.46	2.00	61.23	58.00	6.99	10.00	11.53	4.16
13.88	12.00	4.14	2.00	58.16	58.00	7.60	10.00	11.34	4.88
10.81	12.00	3.32	2.00	63.39	58.00	7.45	10.00	11.08	3.95
11.50	12.00	3.76	2.00	60.88	58.00	8.13	10.00	11.11	4.62
11.13	12.00	4.14	2.00	60.41	58.00	8.77	10.00	10.53	5.02
11.56	12.00	4.66	2.00	60.77	58.00	7.36	10.00	10.96	4.69
11.56	12.00	4.77	2.00	59.18	58.00	6.00	10.00	11.83	6.66
11.13	12.00	4.55	2.00	60.87	58.00	6.22	10.00	11.80	5.43
12.94	12.00	4.78	2.00	59.10	58.00	6.42	10.00	11.36	5.40
11.06	12.00	4.26	2.00	64.20	58.00	6.00	10.00	10.46	4.02
11.38	12.00	4.75	2.00	62.21	58.00	6.66	10.00	10.33	4.67
11.94	12.00	6.92	2.00	61.33	58.00	6.35	10.00	8.23	5.23
11.88	12.00	6.53	2.00	61.49	58.00	5.50	10.00	10.05	4.55
11.97	12.00	6.11	2.00	58.30	58.00	7.28	10.00	10.78	5.56

MOLASSES

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
M. C. Peters Mill Co., Omaha, Neb.		
Arab (alfalfa, corn, oats, barley and molasses)........	2521	1

CORN

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Atchison Live Stock Co., Atchison, Kan.		
Corn Chops..	2487	1
	2877	14
	3103	4
	3237	1
	3240	2
	3336	4
	3664	2
Average..		28
Barnett and O'Neal, Alexandria, La.		
Corn Chops..	2872	13
	3101	6
	3216	8
	3334	10
	3466	8
	3652	14
	3824	7
	3926	9
	4044	1
	4148	1
	4240	3
	4282	5
	4358	6
	4433	5
	4576	1
	4665	4
	4684	1
	4798	2
	4891	3
	4973	5
	5133	2
	5249	2
	5352	2
Average..		118

FEEDS.

PROTEIN		FAT		CARBOHY-DRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
10.78	11.50	2.42	3.00	61.95	67.00	8.06	4.50	12.00	4.79

CHOPS.

9.38	5.50	3.28	3.00	74.52	39.00	1.71	19.50	10.06	1.05
9.31	5.50	3.67	3.00	73.17	39.00	1.99	19.50	10.58	1.28
8.75	5.50	3.80	3.00	71.14	39.00	1.99	19.50	13.16	1.16
8.69	5.50	3.54	3.00	71.47	39.00	1.87	19.50	13.18	1.25
9.19	5.50	4.18	3.00	70.42	39.00	2.08	19.50	12.79	1.34
9.06	5.50	4.07	3.00	70.90	39.00	1.99	19.50	12.76	1.22
9.19	5.50	4.42	3.00	71.38	39.00	2.46	19.50	11.27	1.28
9.08	5.50	3.87	3.00	71.85	39.00	2.01	19.50	11.97	1.22

9.38	9.00	3.74	4.00	72.11	69.00	2.25	15.00	11.13	1.39
8.88	9.00	3.69	4.00	72.14	69.00	1.92	15.00	12.06	1.31
9.00	9.00	3.32	4.00	73.59	69.00	1.84	15.00	11.12	1.13
8.69	9.00	4.03	4.00	72.04	69.00	1.94	15.00	12.06	1.24
8.63	9.00	3.32	4.00	72.61	69.00	1.71	15.00	12.59	1.14
8.81	9.00	3.86	4.00	71.10	69.00	1.93	15.00	12.95	1.35
8.81	9.00	3.24	4.00	72.76	69.00	1.67	15.00	12.43	1.09
9.19	9.00	3.28	4.00	72.47	69.00	2.09	15.00	11.73	1.24
8.81	9.00	3.28	4.00	72.10	69.00	1.81	15.00	12.87	1.13
9.12	9.00	4.49	4.00	69.99	69.00	2.36	15.00	12.70	1.34
9.38	9.00	3.97	4.00	73.07	69.00	1.92	15.00	10.51	1.15
9.44	9.00	3.86	4.00	73.44	69.00	2.00	15.00	10.01	1.25
8.63	9.00	4.22	4.00	72.63	69.00	1.95	15.00	11.38	1.19
9.31	9.00	3.70	4.00	73.10	69.00	1.98	15.00	10.75	1.16
8.56	9.00	3.33	4.00	75.52	69.00	1.77	15.00	9.60	1.22
8.94	9.00	3.35	4.00	73.81	69.00	1.73	15.00	11.04	1.13
8.88	9.00	3.02	4.00	74.18	69.00	1.86	15.00	10.93	1.13
8.88	9.00	3.55	4.00	73.16	69.00	1.86	15.00	11.32	1.23
8.94	9.00	3.44	4.00	73.73	69.00	1.76	15.00	10.90	1.23
9.72	9.00	4.12	4.00	71.76	69.00	2.11	15.00	10.92	1.37
8.78	9.00	3.61	4.00	71.75	69.00	1.87	15.00	12.56	1.43
9.00	9.00	3.63	4.00	72.92	69.00	1.96	15.00	11.02	1.47
9.44	9.00	4.52	4.00	73.08	69.00	2.10	15.00	9.40	1.46
9.05	9.00	3.68	4.00	72.70	69.00	1.93	15.00	11.39	1.25

CORN

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Blair Milling Co., Atchison, Kan.		
Blair's Corn Chops	3348	1
	3483	1
	3513	3
	3571	2
	3923	2
Average		9
Blodgett Elevator and Grain Co., Blodgett, Mo.		
Corn Chops	2744	1
	3853	1
Average		2
E. C. Buchanan and Co., Memphis, Tenn.		
Andes Corn Chops	2282	3
	3382	5
	3592	1
	4027	2
	4350	2
	4885	1
Average		13
T. H. Bunch, Little Rock, Ark.		
Corn Chops	2197	7
	2394	29
	2501	20
	2609	20
	2698	16
	2731	3
	2762	4
	2791	4
	2843	15
	2948	16
	3021	2
	3037	7
	3108	6
	3164	3
	3211	11
	3267	3
	3326	9

CHOPS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
9.19	10.50	3.86	5.00	71.59	69.60	2.01	3.10	12.00	1.35
9.19	10.50	3.75	5.00	70.94	69.60	2.14	3.10	12.75	1.23
9.13	10.50	3.54	5.00	72.70	69.60	1.93	3.10	11.43	1.27
9.00	10.50	5.07	5.00	70.81	69.60	2.26	3.10	11.42	1.44
8.63	10.50	3.97	5.00	72.19	69.60	1.97	3.10	11.92	1.32
9.03	10.50	4.04	5.00	71.65	69.60	2.06	3.10	11.90	1.32
9.58	12.00	3.20	4.00	69.18	75.00	1.88	2.00	14.91	1.25
9.25	12.00	3.95	4.00	72.53	75.00	2.10	2.00	10.87	1.30
9.42	12.00	3.57	4.00	70.86	75.00	1.99	2.00	12.89	1.27
9.69	9.25	3.90	3.87	70.91	70.32	2.13	1.56	12.24	1.13
8.88	9.25	3.52	3.87	72.94	70.32	2.07	1.56	11.34	1.25
9.38	9.25	3.99	3.87	69.83	70.32	2.13	1.56	13.43	1.24
9.50	9.25	3.87	3.87	72.39	70.32	1.87	1.56	11.19	1.18
9.44	9.25	3.62	3.87	72.13	70.32	2.40	1.56	11.09	1.32
8.38	9.25	3.31	3.87	73.59	70.32	1.93	1.56	11.48	1.31
9.21	9.25	3.70	3.87	71.96	70.32	2.09	1.56	11.80	1.24
9.50	6.00	4.03	3.00	71.38	60.00	2.02	2.20	11.68	1.39
9.50	6.00	3.73	3.00	72.55	60.00	2.09	2.20	10.98	1.15
9.57	6.00	3.85	3.00	72.35	60.00	1.85	2.20	11.16	1.22
9.45	6.00	3.74	3.00	72.85	60.00	1.92	2.20	10.88	1.16
9.38	6.00	3.97	3.00	71.55	60.00	2.01	2.20	11.78	1.31
9.54	6.00	4.02	3.00	70.29	60.00	1.92	2.20	13.03	1.20
9.60	6.00	3.58	3.00	70.61	60.00	1.98	2.20	12.80	1.43
9.06	6.00	3.51	3.00	72.87	60.00	1.98	2.20	11.33	1.25
9.56	6.00	3.54	3.00	69.88	60.00	2.02	2.20	13.70	1.30
9.25	6.00	3.90	3.00	71.25	60.00	2.00	2.20	12.34	1.26
9.25	6.00	4.20	3.00	71.01	60.00	2.06	2.20	12.21	1.27
9.31	6.00	3.25	3.00	72.21	60.00	2.02	2.20	12.03	1.18
9.06	6.00	3.60	3.00	71.07	60.00	1.96	2.20	13.19	1.12
9.44	6.00	3.44	3.00	72.00	60.00	1.80	2.20	12.05	1.27
9.25	6.00	3.73	3.00	71.21	60.00	1.91	2.20	12.54	1.36
8.81	6.00	4.03	3.00	71.73	60.00	2.08	2.20	12.12	1.23
9.25	6.00	4.23	3.00	71.86	60.00	2.33	2.20	11.12	1.21

CORN

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
T. H. Bunch—Continued.		
	3392	9
	3468	9
	3515	8
	3572	3
	3604	7
	3667	10
	3725	11
	3827	5
	3893	14
	3929	3
	3963	6
	4031	3
	4060	5
	4096	10
	4156	12
	4206	4
	4236	9
	4280	3
	4309	15
	4362	9
	4409	8
	4441	14
	4490	4
	4511	7
	4567	11
	4590	6
	4619	4
	4671	11
	4714	7
	4760	15
	4786	7
	4844	1
	4861	10
	4896	3
	4918	11
	4945	1
	4966	8
	5027	37
	5074	2
	5102	16
	5173	1
	5192	4
	5200	1
	5239	9
	5273	3

CHOPS.

PROTEIN		FAT		CARBOHY-DRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
9.13	6.00	4.40	3.00	71.73	60.00	2.30	2.20	11.10	1.34
9.00	6.00	3.66	3.00	71.41	60.00	1.97	2.20	12.62	1.34
9.63	6.00	4.20	3.00	71.13	60.00	2.43	2.20	11.26	1.35
9.44	6.00	3.94	3.00	71.91	60.00	1.98	2.20	11.49	1.24
9.00	6.00	3.92	3.00	73.07	60.00	2.13	2.20	10.49	1.39
8.63	6.00	3.71	3.00	72.03	60.00	2.06	2.20	12.39	1.18
8.63	6.00	3.80	3.00	72.26	60.00	2.21	2.20	11.79	1.31
9.44	6.00	4.08	3.00	71.04	60.00	2.11	2.20	12.00	1.33
9.38	6.00	4.01	3.00	72.70	60.00	2.34	2.20	10.21	1.36
9.44	6.00	3.59	3.00	72.19	60.00	2.30	2.20	11.23	1.25
9.75	6.00	3.98	3.00	70.91	60.00	2.23	2.20	11.83	1.30
9.38	6.00	3.56	3.00	73.33	60.00	1.86	2.20	10.70	1.17
9.06	6.00	3.97	3.00	70.48	60.00	2.29	2.20	12.60	1.60
9.44	6.00	4.48	3.00	71.75	60.00	2.20	2.20	10.71	1.42
9.40	6.00	3.88	3.00	72.17	60.00	2.00	2.20	11.15	1.40
9.44	6.00	4.12	3.00	71.70	60.00	2.03	2.20	11.35	1.36
9.44	6.00	4.09	3.00	71.95	60.00	2.24	2.20	10.80	1.48
9.06	6.00	4.14	3.00	72.42	60.00	2.44	2.20	10.36	1.58
9.69	6.00	4.14	3.00	71.39	60.00	2.35	2.20	10.99	1.44
8.81	6.00	4.03	3.00	72.53	60.00	2.05	2.20	11.25	1.33
9.06	6.00	4.24	3.00	72.21	60.00	1.97	2.20	11.13	1.39
9.44	6.00	4.26	3.00	71.12	60.00	2.10	2.20	11.56	1.52
9.56	6.00	3.64	3.00	72.20	60.00	2.02	2.20	11.26	1.32
9.50	6.00	4.41	3.00	70.78	60.00	2.65	2.20	11.36	1.30
9.19	6.00	3.55	3.00	73.26	60.00	1.92	2.20	10.61	1.47
8.56	6.00	4.08	3.00	72.28	60.00	2.01	2.20	11.83	1.24
9.06	6.00	4.05	3.00	73.18	60.00	2.19	2.20	10.24	1.28
8.94	6.00	3.33	3.00	73.91	60.00	1.91	2.20	10.64	1.27
9.63	6.00	4.20	3.00	71.96	60.00	2.14	2.20	10.59	1.48
8.88	6.00	4.28	3.00	72.39	60.00	1.98	2.20	11.14	1.33
8.94	6.00	3.93	3.00	73.24	60.00	2.07	2.20	10.49	1.33
9.19	6.00	3.30	3.00	72.22	60.00	1.92	2.20	11.96	1.41
8.56	6.00	3.32	3.00	73.92	60.00	1.86	2.20	11.11	1.23
8.94	6.00	3.70	3.00	73.59	60.00	1.84	2.20	10.62	1.31
8.88	6.00	3.85	3.00	72.86	60.00	2.10	2.20	10.96	1.35
8.88	6.00	3.68	3.00	72.73	60.00	2.03	2.20	11.40	1.28
9.81	6.00	4.23	3.00	70.83	60.00	2.56	2.20	11.17	1.40
9.00	6.00	4.24	3.00	72.02	60.00	2.40	2.20	10.96	1.38
9.69	6.00	4.96	3.00	69.66	60.00	2.61	2.20	10.92	2.16
8.63	6.00	3.59	3.00	72.69	60.00	1.92	2.20	11.81	1.36
9.19	6.00	5.47	3.00	69.97	60.00	2.60	2.20	10.82	1.95
9.03	6.00	3.74	3.00	71.64	60.00	2.17	2.20	11.47	1.95
9.31	6.00	4.43	3.00	71.54	60.00	2.30	2.20	10.54	1.88
9.38	6.00	3.62	3.00	71.83	60.00	2.30	2.20	11.45	1.42
9.31	6.00	3.91	3.00	72.16	60.00	2.02	2.20	11.07	1.53

	CORN	
Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
T. H. Bunch—Continued.		
	5315	8
	5330	11
	5390	5
	5422	4
	5442	4
Average		563
Corn Chops	3448	1
	3534	1
	3716	1
	4660	1
	4672	3
Average		7
Burrus Mill and Elevator Co., Fort Worth, Tex.		
Burrus' Corn Chops	2582	1
	3182	1
	3295	1
	3505	1
	4042	1
	4204	2
	4367	1
	4466	1
	5090	1
	5127	2
	5384	1
	5457	1
Average		14
Canadian Mill and Elevator Co., El Reno, Okla.		
Corn Chops	2435	3
Charleston Milling Co., Charleston, Mo.		
Corn Chops	2927	1

CHOPS.

PROTEIN		FAT		CARBOHY-DRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
9.38	6.00	3.65	3.00	71.76	60.00	1.97	2.20	11.74	1.50
9.44	6.00	4.23	3.00	72.06	60.00	2.66	2.20	10.01	1.60
9.47	6.00	3.25	3.00	73.78	60.00	2.00	2.20	10.08	1.42
9.25	6.00	3.95	3.00	72.56	60.00	2.10	2.20	10.74	1.40
8.88	6.00	3.42	3.00	73.22	60.00	2.07	2.20	10.45	1.96
—	—	—	—	—	—	—	—	—	—
9.24	6.00	3.92	3.00	71.98	60.00	2.12	2.20	11.36	1.38
8.44	9.88	4.07	4.17	72.36	71.95	2.06	2.00	11.83	1.24
9.75	9.88	3.86	4.17	70.53	71.95	2.02	2.00	12.54	1.30
9.13	9.88	3.50	4.17	72.34	71.95	2.28	2.00	11.52	1.23
8.50	9.88	3.23	4.17	73.37	71.95	1.79	2.00	11.89	1.22
8.94	9.88	3.48	4.17	73.21	71.95	1.87	2.00	11.24	1.26
—	—	—	—	—	—	—	—	—	—
8.95	9.88	3.63	4.17	72.36	71.95	2.00	2.00	11.81	1.25
9.66	9.62	3.64	4.12	72.00	71.43	2.09	2.68	11.15	1.46
9.75	9.62	4.26	4.12	69.02	71.43	2.06	2.68	13.62	1.29
10.38	9.62	4.09	4.12	69.99	71.43	2.09	2.68	12.07	1.38
10.63	9.62	4.70	4.12	68.75	71.43	2.62	2.68	11.69	1.61
10.56	9.62	3.35	4.12	71.67	71.43	2.03	2.68	10.97	1.42
10.50	9.62	4.38	4.12	70.62	71.43	2.35	2.68	10.63	1.52
10.31	9.62	4.52	4.12	70.81	71.43	2.03	2.68	11.11	1.22
10.06	9.62	3.98	4.12	71.81	71.43	2.99	2.68	9.81	1.35
8.19	9.62	3.29	4.12	72.92	71.43	2.15	2.68	12.25	1.20
11.56	9.62	4.30	4.12	67.74	71.43	2.60	2.68	12.08	1.72
10.06	9.62	3.26	4.12	71.62	71.43	2.50	2.68	10.74	1.82
10.31	9.62	3.97	4.12	70.49	71.43	2.69	2.68	10.30	2.24
—	—	—	—	—	—	—	—	—	—
10.16	9.62	3.98	4.12	70.62	71.43	2.35	2.68	11.37	1.52
9.44	9.50	3.84	4.51	72.10	65.00	2.01	3.00	11.32	1.29
9.93	12.00	3.51	3.65	71.44	64.34	2.05	2.87	11.93	1.14

CORN

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Cunningham Commission Co., Little Rock, Ark. Corn Chops	2430	20
	2561	6
	2687	1
	2783	4
	2875	22
	2956	5
	3172	1
	3246	5
	3328	6
	3426	3
	3464	3
	3557	5
	3606	4
	3662	4
	3775	5
	3848	3
	3888	6
	3952	1
	4028	2
	4115	3
	4275	1
	4296	3
	4396	1
	4506	3
	4603	1
	4635	1
	4694	1
	4750	3
	4814	1
	4879	1
	4967	5
	5021	5
	5104	10
	5196	1
	5244	2
	5306	1
	5331	6
	5408	1
	5423	2
	5450	1
Average		159
Daniels Grain Co., Little Rock, Ark. Corn Chops	3781	1

CHOPS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
9.31	9.00	3.93	4.50	72.82	69.00	2.08	3.00	10.69	1.17
9.25	9.00	4.04	4.50	71.42	69.00	2.05	3.00	11.87	1.37
8.88	9.00	4.50	4.50	68.45	69.00	2.41	3.00	14.47	1.29
8.88	9.00	3.80	4.50	71.28	69.00	1.93	3.00	12.94	1.17
9.29	9.00	3.74	4.50	73.14	69.00	2.03	3.00	10.56	1.24
9.31	9.00	3.89	4.50	71.76	69.00	2.12	3.00	11.63	1.29
8.25	9.00	3.69	4.50	71.21	69.00	1.92	3.00	13.70	1.23
9.25	9.00	4.31	4.50	68.46	69.00	2.08	3.00	13.26	1.44
8.94	9.00	4.71	4.50	71.73	69.00	2.39	3.00	10.77	1.46
9.19	9.00	4.73	4.50	71.08	69.00	2.44	3.00	11.01	1.55
10.38	9.00	3.77	4.50	70.64	69.00	1.66	3.00	12.36	1.19
9.44	9.00	4.14	4.50	71.50	69.00	1.98	3.00	11.66	1.28
9.13	9.00	3.88	4.50	72.08	69.00	2.13	3.00	11.48	1.30
9.50	9.00	3.69	4.50	71.90	69.00	1.91	3.00	11.87	1.13
10.13	9.00	4.03	4.50	71.39	69.00	1.78	3.00	11.32	1.35
10.38	9.00	4.33	4.50	70.59	69.00	2.03	3.00	11.40	1.27
9.44	9.00	4.07	4.50	72.31	69.00	2.23	3.00	10.62	1.33
8.87	9.00	3.50	4.50	71.45	69.00	2.12	3.00	12.71	1.35
9.00	9.00	4.29	4.50	72.61	69.00	1.88.	3.00	10.94	1.28
10.13	9.00	3.81	4.50	72.26	69.00	2.18	3.00	10.35	1.27
9.25	9.00	3.97	4.50	72.88	69.00	2.30	3.00	10.20	1.40
9.56	9.00	3.41	4.50	72.82	69.00	2.03	3.00	10.94	1.24
8.44	9.00	3.74	4.50	73.94	69.00	1.96	3.00	10.60	1.32
9.19	9.00	3.67	4.50	72.58	69.00	2.02	3.00	11.27	1.27
8.81	9.00	3.89	4.50	72.68	69.00	1.95	3.00	11.39	1.28
8.56	9.00	3.93	4.50	72.54	69.00	1.93	3.00	11.68	1.36
9.19	9.00	4.39	4.50	71.90	69.00	2.19	3.00	11.00	1.33
8.56	9.00	3.65	4.50	73.39	69.00	1.85	3.00	11.48	1.07
9.63	9.00	3.57	4.50	74.11	69.00	1.75	3.00	9.79	1.15
9.13	9.00	3.42	4.50	72.72	69.00	1.78	3.00	11.82	1.13
9.00	9.00	4.03	4.50	72.53	69.00	2.23	3.00	10.90	1.31
8.63	9.00	4.53	4.50	71.72	69.00	2.75	3.00	10.87	1.50
8.63	9.00	3.39	4.50	72.79	69.00	2.02	3.00	11.64	1.53
7.44	9.00	2.66	4.50	74.12	69.00	1.36	3.00	12.61	1.81
8.81	9.00	3.95	4.50	71.57	69.00	2.24	3.00	11.93	1.50
9.88	9.00	4.57	4.50	70.62	69.00	2.57	3.00	10.83	1.53
8.56	9.00	3.79	4.50	73.69	69.00	2.69	3.00	9.77	1.50
9.25	9.00	4.57	4.50	70.10	69.00	2.45	3.00	12.02	1.61
9.44	9.00	4.03	4.50	72.01	69.00	2.17	3.00	10.93	1.42
8.75	9.00	3.32	4.50	72.50	69.00	2.42	3.00	11.53	1.48
9.17	9.00	3.93	4.50	71.98	69.00	2.11	3.00	11.47	1.34
8.94	9.04	3.37	3.06	72.92	72.03	1.92	2.03	11.79	1.06

CORN

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Davis Milling Co., St. Joseph, Mo.		
Pure Corn Chops	3026	1
	3168	1
	3236	1
	3281	5
	3715	1
	4034	1
	4182	1
	4250	1
	2587	1
	5151	1
Average		14
Davis and Andrews Co., Memphis, Tenn.		
Corn Chops	3350	1
	3753	1
	3987	1
	4368	1
	5043	1
	5082	1
Average		6
Enid Mill and Elevator Co., Enid, Okla.		
Corn Chops	4045	1
	4485	1
Average		2
Lev. Fowler, Kansas City, Mo.		
Corn Chops	2398	17
	2611	2
	2931	3
	3028	1
	3114	2
	3163	3
	3279	2
	3416	3
	3517	4
	3573	3
	3648	2
	4169	3

CHOPS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
9.69	8.00	3.50	3.25	74.34	70.00	1.99	1.80	9.25	1.23
8.55	8.00	3.44	3.25	71.93	70.00	1.82	1.80	13.12	1.14
9.31	8.00	4.66	3.25	69.94	70.00	2.10	1.80	12.62	1.37
8.69	8.00	3.80	3.25	71.63	70.00	2.17	1.80	12.47	1.24
9.38	8.00	3.92	3.25	70.53	70.00	2.16	1.80	12.70	1.31
9.94	8.00	3.94	3.25	70.27	70.00	1.97	1.80	12.34	1.54
9.19	8.00	4.22	3.25	72.31	70.00	2.36	1.80	10.49	1.43
8.75	8.00	3.52	3.25	73.89	70.00	1.79	1.80	10.81	1.24
9.24	8.00	4.17	3.25	71.67	70.00	2.09	1.80	11.52	1.31
8.94	8.00	3.55	3.25	72.88	70.00	2.05	1.80	10.77	1.81
9.17	8.00	3.87	3.25	71.94	70.00	2.05	1.80	11.61	1.36
9.81	8.50	4.73	4.43	70.92	71.47	2.06	3.50	11.01	1.47
8.63	8.50	3.64	4.43	72.36	71.47	1.62	3.50	12.46	1.29
9.00	8.50	3.43	4.43	72.35	71.47	2.17	3.50	11.72	1.33
10.44	8.50	3.90	4.43	71.49	71.47	2.24	3.50	10.67	1.26
8.56	8.50	3.60	4.43	74.82	71.47	1.96	3.50	9.72	1.34
8.25	8.50	3.11	4.43	73.81	71.47	1.98	3.50	11.60	1.25
9.12	8.50	3.73	4.43	72.63	71.47	2.00	3.50	11.20	1.32
10.69	10.80	3.68	2.25	70.84	75.25	1.76	2.25	11.69	1.34
10.56	10.80	3.43	2.25	72.58	75.25	2.15	2.25	9.99	1.29
10.63	10.80	3.55	2.25	71.71	75.25	1.96	2.25	10.84	1.31
9.87	7.80	3.35	4.20	74.80	72.32	2.07	3.10	8.72	1.19
10.11	7.80	4.61	4.20	71.63	72.32	2.20	3.10	10.08	1.37
9.06	7.80	3.48	4.20	73.41	72.32	1.91	3.10	10.96	1.18
8.63	7.80	4.47	4.20	71.34	72.32	2.14	3.10	12.09	1.33
9.50	7.80	4.53	4.20	67.93	72.32	2.41	3.10	14.27	1.26
9.19	7.80	4.36	4.20	71.67	72.32	1.96	3.10	11.51	1.31
9.50	7.80	4.60	4.20	71.36	72.32	2.37	3.10	10.76	1.41
8.50	7.80	3.83	4.20	73.74	72.73	1.87	3.10	10.79	1.27
8.13	7.80	3.48	4.20	72.24	72.32	1.95	3.10	11.89	2.31
8.69	7.80	4.06	4.20	72.60	72.32	2.05	3.10	11.15	1.45
8.13	7.80	3.85	4.20	72.63	72.32	1.97	3.10	12.15	1.27
9.50	7.80	4.43	4.20	72.07	72.32	2.18	3.10	10.40	1.42

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Lev Fowler—Continued.		
	4299	15
	4515	7
	4751	3
	5016	7
	5172	1
	5294	1
	5333	3
	5435	1
Average		83
Fowler Commission Co., Rosedale, Kan.		
Corn Chops	2429	20
	2568	6
	2725	2
	2873	2
	2950	3
	3036	4
	3099	1
	3111	2
	3185	2
	3239	2
	3327	6
	3427	4
	3465	5
	3540	2
	3612	4
	3714	1
	3965	2
	4029	2
	4135	3
	4242	2
	4328	2
	4348	1
	4428	3
	4508	3
	4571	2
	4677	3
	4756	6
	4787	3
	4895	2
	5068	1
	5103	5
	5170	2
	5243	2

CHOPS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
10.19	7.80	3.87	4.20	72.81	72.32	2.40	3.10	9.21	1.52
9.25	7.80	3.95	4.20	72.69	72.32	2.12	3.10	10.65	1.34
9.56	7.80	3.91	4.20	72.11	72.32	2.01	3.10	11.16	1.25
8.81	7.80	3.75	4.20	72.45	72.32	2.30	3.10	11.31	1.38
8.88	7.80	3.10	4.20	72.43	72.32	1.88	3.10	12.54	1.17
8.88	7.80	3.15	4.20	74.42	72.32	1.89	3.10	10.28	1.38
9.00	7.80	3.69	4.20	74.10	72.32	2.31	3.10	9.30	1.69
9.81	7.80	5.39	4.20	70.96	72.32	2.83	3.10	9.51	1.50
9.15	7.80	4.01	4.20	72.37	72.32	2.14	3.10	10.93	1.40
9.19	9.94	3.50	4.67	72.92	71.55	1.95	2.19	11.21	1.23
10.19	9.94	3.82	4.67	70.53	71.55	2.16	2.19	11.99	1.31
9.25	9.94	3.82	4.67	70.96	71.55	2.36	2.19	12.28	1.33
9.50	9.94	3.81	4.67	72.66	71.55	2.11	2.19	10.50	1.42
9.56	9.94	3.54	4.67	72.63	71.55	1.86	2.19	11.02	1.39
9.56	9.94	3.60	4.67	71.91	71.55	2.01	2.19	11.64	1.28
9.00	9.94	3.44	4.67	70.92	71.55	2.17	2.19	13.09	1.38
8.81	9.94	3.56	4.67	70.17	71.55	1.94	2.19	14.34	1.18
9.50	9.94	4.37	4.67	70.71	71.55	2.52	2.19	11.52	1.38
9.19	9.94	4.12	4.67	70.51	71.55	2.12	2.19	12.57	1.49
9.06	9.94	4.80	4.67	71.50	71.55	2.29	2.19	11.02	1.33
8.50	9.94	4.20	4.67	72.03	71.55	2.33	2.19	11.63	1.31
8.69	9.94	3.17	4.67	71.89	71.55	1.67	2.19	13.37	1.21
9.06	9.94	3.74	4.67	72.36	71.55	2.03	2.19	11.50	1.31
8.88	9.94	3.74	4.67	73.24	71.55	1.99	2.19	10.90	1.25
8.25	9.94	3.75	4.67	73.67	71.55	2.71	2.19	10.40	1.22
9.63	9.94	4.24	4.67	71.10	71.55	2.10	2.19	11.67	1.28
8.75	9.94	4.15	4.67	72.77	71.55	2.03	2.19	10.88	1.42
9.31	9.94	3.46	4.67	71.46	71.55	2.10	2.19	12.33	1.34
8.37	9.94	3.11	4.67	73.58	71.55	1.82	2.19	12.03	1.09
9.56	9.94	4.21	4.67	71.74	71.55	2.40	2.19	10.74	1.35
8.38	9.94	3.14	4.67	73.78	71.55	1.87	2.19	11.69	1.14
8.50	9.94	3.54	4.67	74.05	71.55	2.02	2.19	10.59	1.30
9.63	9.94	4.58	4.67	70.86	71.55	2.55	2.19	10.84	1.54
9.00	9.94	3.76	4.67	73.78	71.55	1.77	2.19	10.42	1.27
9.19	9.94	3.57	4.67	71.91	71.55	2.06	2.19	11.92	1.35
9.31	9.94	3.50	4.67	72.65	71.55	1.82	2.19	11.39	1.33
9.00	9.94	3.84	4.67	73.29	71.55	2.13	2.19	10.41	1.33
8.88	9.94	3.64	4.67	73.50	71.55	1.89	2.19	10.88	1.21
9.06	9.94	3.55	4.67	72.90	71.55	2.19	2.19	10.92	1.38
8.50	9.94	3.46	4.67	73.39	71.55	1.68	2.19	11.57	1.40
8.38	9.94	4.78	4.67	70.71	71.55	2.42	2.19	11.80	1.91
8.69	9.94	3.43	4.67	72.48	71.55	1.89	2.19	12.05	1.46

CORN

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Fowler Commission Co.—Continued.	5272	2
	5305	1
	5347	2
	5417	1
Average		116
F. B. Gilbert Grain Co., Wagoner, Okla.		
Corn Chops	3872	1
B. F. Glover and Son Commission Co., New Orleans, La.		
New Basin Chops	2207	35
	2274	2
	2447	9
	2602	4
	2734	2
	2801	3
	2851	1
	2949	3
	3112	3
	3170	1
	3249	4
	3341	3
	3458	1
	3542	2
	3646	2
	3828	3
	3964	2
	4063	2
	4132	2
	4386	1
	4447	2
	4639	1
	4697	1
	4707	2
	4797	2
	4872	1
	4598	1
	4911	2
	2370	4
	4960	2
	5013	2
	5128	2

CHOPS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
9.06	9.94	3.78	4.67	72.97	71.55	2.00	2.19	10.81	1.38
8.63	9.94	3.21	4.67	73.59	71.55	1.98	2.19	11.17	1.42
9.00	9.94	4.07	4.67	73.25	71.55	1.90	2.19	10.33	1.45
9.69	9.94	5.98	4.67	70.23	71.55	2.87	2.19	9.47	1.76
9.05	9.94	3.85	4.67	72.22	71.55	2.10	2.19	11.43	1.35
10.69	10.38	4.00	4.46	69.95	71.86	2.32	2.02	11.82	1.22
9.56	10.90	3.68	2.90	72.20	70.30	1.98	1.90	11.22	1.36
9.38	10.90	3.36	2.90	72.46	70.30	1.92	1.90	11.33	1.55
9.69	10.90	3.54	2.90	73.33	70.30	1.83	1.90	10.38	1.23
10.14	10.90	3.42	2.90	71.89	70.30	2.28	1.90	11.03	1.24
9.11	10.90	3.37	2.90	72.34	70.30	1.72	1.90	12.34	1.12
9.25	10.90	3.55	2.90	73.31	70.30	2.02	1.90	10.62	1.25
9.13	10.90	3.88	2.90	69.91	70.30	2.08	1.90	13.82	1.18
9.19	10.90	3.35	2.90	72.76	70.30	1.83	1.90	11.75	1.12
8.69	10.90	3.78	2.90	70.37	70.30	2.11	1.90	13.75	1.30
8.69	10.90	3.73	2.90	69.44	70.30	2.01	1.90	14.82	1.31
8.81	10.90	3.71	2.90	70.76	70.30	2.04	1.90	13.34	1.34
8.88	10.90	3.66	2.90	71.67	70.30	1.77	1.90	12.77	1.25
9.06	10.90	3.54	2.90	69.97	70.30	2.02	1.90	13.87	1.54
8.94	10.90	3.56	2.90	72.44	70.30	2.30	1.90	11.45	1.31
8.56	10.90	3.11	2.90	73.35	70.30	1.84	1.90	11.91	1.23
8.88	10.90	4.28	2.90	70.93	70.30	2.36	1.90	12.11	1.44
8.63	10.90	3.70	2.90	71.71	70.30	2.32	1.90	11.85	1.79
8.69	10.90	3.44	2.90	71.41	70.30	2.44	1.90	12.33	1.69
8.81	10.90	3.46	2.90	72.72	70.30	1.87	1.90	11.88	1.26
9.13	10.90	3.72	2.90	73.60	70.30	2.34	1.90	9.93	1.28
9.06	10.90	3.43	2.90	74.16	70.30	2.06	1.90	10.00	1.29
8.50	10.90	3.68	2.90	72.70	70.30	2.22	1.90	11.44	1.46
8.69	10.90	4.00	2.90	72.99	70.30	2.56	1.90	10.37	1.39
9.00	10.90	4.06	2.90	71.70	70.30	2.36	1.90	11.48	1.40
9.00	10.90	3.98	2.90	71.49	70.30	2.41	1.90	11.69	1.43
8.25	10.90	3.65	2.90	73.83	70.30	1.86	1.90	11.15	1.28
8.63	10.90	3.71	2.90	73.80	70.30	2.54	1.90	9.92	1.40
8.56	10.90	3.38	2.90	72.84	70.30	2.34	1.90	11.56	1.32
9.25	10.90	3.53	2.90	72.14	70.30	2.40	1.90	11.40	1.28
8.94	10.90	3.56	2.90	71.40	70.30	2.44	1.90	12.34	1.32
8.31	10.90	3.48	2.90	73.71	70.30	2.16	1.90	11.02	1.32
8.31	10.90	3.13	2.90	72.56	70.30	2.03	1.90	12.48	1.49

CORN

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
B. F. Glover and Son Commission Co.—Continued.		
	5207	2
	5279	2
	5345	2
	5439	2
Average		115
J. S. Gordon Co., Beaumont, Tex.		
Corn Chops	3608	2
	4372	1
	4650	1
Average		4
Mixed Corn Chops	3937	1
Green-Shoemaker Co., Ltd., Crowley, La.		
Corn Chops	2215	4
	3349	1
Average		5
Hammond Planting and Manufacturing Co., Hammond, La.		
Corn Chops	2523	1
	2635	3
Average		4
Hamiter and Bushby, Shreveport, La.		
Corn Chops	2393	66
	2399	78
	2449	42
	2537	24
	2671	21
	2737	13
	2800	5
	2827	8
	2879	9
	2953	4
	3002	2
	3030	5

CHOPS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
8.19	10.90	3.90	2.90	72.35	70.30	2.34	1.90	11.69	1.53
7.75	10.90	3.51	2.90	73.87	70.30	2.21	1.90	10.95	1.71
8.88	10.90	3.99	2.90	72.01	70.30	2.65	1.90	10.91	1.56
9.00	10.90	3.59	2.90	73.52	70.30	2.22	1.90	10.38	1.29
8.88	10.90	3.62	2.90	72.27	70.30	2.16	1.90	11.70	1.37
10.06	9.00	3.66	4.00	70.95	70.00	2.88	2.00	10.76	1.69
10.00	9.00	3.91	4.00	69.75	70.00	3.52	2.00	10.82	2.00
10.25	9.00	3.14	4.00	71.01	70.00	3.43	2.00	10.25	1.92
10.10	9.00	3.57	4.00	70.57	70.00	3.28	2.00	10.61	1.87
9.31	9.01	3.71	3.24	71.15	70.00	3.16	3.00	10.96	1.71
9.38	8.44	4.26	4.19	71.68	69.92	1.86	1.95	11.51	1.31
9.31	8.44	3.78	4.19	68.99	69.92	2.29	1.95	13.25	2.38
9.35	8.44	4.02	4.19	70.33	69.92	2.08	1.95	12.38	1.84
9.16	9.38	3.34	3.02	73.14	73.27	2.13	2.14	10.94	1.29
9.18	9.38	4.05	3.02	72.89	73.27	2.09	2.14	10.56	1.23
9.17	9.38	3.69	3.02	73.02	73.27	2.11	2.14	10.75	1.26
9.69	8.10	4.24	5.00	72.39	72.70	2.26	2.00	10.14	1.28
9.75	8.10	4.30	5.00	73.24	72.70	2.11	2.00	9.25	1.35
9.81	8.10	3.99	5.00	73.13	72.70	2.25	2.00	9.52	1.30
9.26	8.10	4.21	5.00	70.41	72.70	2.22	2.00	12.65	1.25
9.19	8.10	4.26	5.00	68.91	72.70	2.07	2.00	14.41	1.16
8.86	8.10	3.52	5.00	69.70	72.70	1.83	2.00	14.97	1.12
9.71	8.10	4.67	5.00	71.17	72.70	2.53	2.00	10.55	1.37
9.50	8.10	4.42	5.00	68.84	72.70	2.42	2.00	13.55	1.27
9.19	8.10	4.67	5.00	71.00	72.70	2.33	2.00	11.45	1.36
9.13	8.10	4.58	5.00	71.26	72.70	2.48	2.00	11.19	1.36
9.25	8.10	4.02	5.00	71.64	72.70	2.27	2.00	11.56	1.26
9.44	8.10	4.46	5.00	69.59	72.70	2.30	2.00	12.94	1.27

CORN

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Hamiter and Bushby—Continued.		
	3070	7
	3105	8
	3159	8
	3219	8
	3262	6
	3330	8
	3415	12
	3506	9
	3552	11
	3610	6
	3665	7
	3727	12
	3785	7
	3825	6
	3899	16
	3961	8
	4154	28
	4311	22
	4512	31
	4762	49
	5025	25
	5108	8
	5168	8
	5269	10
	5336	9
	5427	12
Average		618
Higginsville Milling Co., Higginsville, Mo.		
Corn Chops	2445	2
	3339	2
	3940	1
	4317	1
	5023	4
	5147	1
	5366	1
Average		12
R. J. House and Co., Kansas City, Mo.		
Corn Chops	2436	4
	2573	2

CHOPS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant,d %	Found %	Guaran't'd %	Found %	Found %
9.50	8.10	4.44	5.00	68.61	72.70	2.37	2.00	13.89	1.19
9.56	8.10	4.38	5.00	70.16	72.70	2.59	2.00	11.97	1.34
9.63	8.10	4.37	5.00	69.87	72.70	2.17	2.00	12.54	1.42
9.25	8.10	4.14	5.00	72.88	72.70	2.06	2.00	10.33	1.34
9.25	8.10	4.98	5.00	69.25	72.70	2.26	2.00	12.77	1.49
9.56	8.10	4.85	5.00	70.57	72.70	2.23	2.00	11.30	1.49
8.63	8.10	4.02	5.00	72.23	72.70	2.06	2.00	11.76	1.30
9.75	8.10	4.62	5.00	70.21	72.70	2.55	2.00	11.43	1.44
9.56	8.10	4.62	5.00	70.35	72.70	2.72	2.00	11.38	1.37
8.94	8.10	4.55	5.00	71.32	72.70	2.57	2.00	11.15	1.47
9.06	8.10	4.62	5.00	69.38	72.70	2.22	2.00	12.58	2.14
9.00	8.10	4.67	5.00	71.24	72.70	2.30	2.00	11.41	1.38
9.44	8.10	4.50	5.00	70.94	72.70	2.98	2.00	10.81	1.38
9.31	8.10	4.49	5.00	70.82	72.70	2.46	2.00	11.50	1.42
9.44	8.10	4.37	5.00	72.08	72.70	2.35	2.00	10.29	1.47
9.69	8.10	3.94	5.00	70.31	72.70	2.65	2.00	11.85	1.56
9.56	8.10	5.00	5.00	70.06	72.70	2.48	2.00	11.40	1.50
9.19	8.10	4.08	5.00	72.25	72.70	2.19	2.00	10.84	1.45
8.69	8.10	4.17	5.00	72.15	72.70	2.21	2.00	11.45	1.33
9.00	8.10	4.23	5.00	72.09	72.70	2.56	2.00	10.72	1.40
8.94	8.10	4.09	5.00	72.54	72.70	2.20	2.00	10.90	1.33
8.63	8.10	4.27	5.00	71.96	72.70	2.40	2.00	10.88	1.86
8.75	8.10	3.64	5.00	72.33	72.70	2.12	2.00	11.72	1.44
9.25	8.10	4.80	5.00	71.31	72.70	2.62	2.00	10.08	1.94
9.50	8.10	4.08	5.00	72.83	72.70	2.14	2.00	9.94	1.51
9.50	8.10	5.00	5.00	72.03	72.70	3.12	2.00	8.77	1.58
9.30	8.10	4.38	5.00	71.08	72.70	2.36	2.00	11.47	1.41
9.81	7.49	4.23	3.87	72.00	55.28	2.17	3.78	10.52	1.27
9.25	7.49	3.79	3.87	71.97	55.28	2.05	3.78	11.70	1.24
8.13	7.49	2.99	3.87	73.18	55.28	1.86	3.78	12.72	1.12
8.88	7.49	3.71	3.87	73.31	55.28	2.10	3.78	10.73	1.27
9.06	7.49	4.48	3.87	70.92	55.28	2.38	3.78	11.55	1.61
8.56	7.49	3.83	3.87	72.64	55.28	2.02	3.78	11.36	1.59
8.63	7.49	2.19	3.87	76.33	55.28	1.45	3.78	10.16	1.24
8.90	7.49	3.60	3.87	72.91	55.28	2.00	3.78	11.25	1.34
9.56	9.40	3.89	3.60	72.26	72.30	2.09	2.30	10.93	1.27
9.06	9.40	3.40	3.60	71.84	72.30	2.07	2.30	12.37	1.26

CORN

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
R. J. House and Co.—Continued.		
	2672	2
	3051	1
	3104	4
	3265	4
	3881	4
	3962	4
	4179	1
	4704	3
	5246	2
Average		31
Corn Chops	4039	1
Kelly Weber and Co., Lake Charles, La.		
Corn Chops	2208	3
	2465	4
	2603	5
	2728	2
	2808	3
	2911	2
	2952	2
	3098	1
	3136	1
	3586	1
	3726	2
	3784	3
	3920	2
	4024	4
	4207	3
	4379	3
	4410	2
	4443	7
	4630	3
	4724	1
	4811	1
	2369	4
	4942	2
	5141	1
	5209	3
	5314	7
	5346	3
	5393	5
	5468	1
Average		81

CHOPS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
8.88	9.40	3.71	3.60	70.96	72.30	1.98	2.30	13.41	1.06
9.13	9.40	3.51	3.60	69.58	72.30	2.15	2.30	14.36	1.27
8.60	9.40	3.31	3.60	71.10	72.30	1.81	2.30	14.04	1.14
8.75	9.40	3.79	3.60	71.12	72.30	2.00	2.30	13.08	1.26
9.06	9.40	3.52	3.60	73.75	72.30	2.09	2.30	10.36	1.22
8.69	9.40	3.48	3.60	72.79	72.30	1.90	2.30	11.82	1.32
8.81	9.40	3.39	3.60	73.10	72.30	2.03	2.30	11.24	1.43
8.50	9.40	3.75	3.60	72.47	72.30	2.46	2.30	11.45	1.37
8.88	9.40	3.40	3.60	72.07	72.30	2.26	2.30	11.79	1.60
8.90	9.40	3.56	3.60	71.91	72.30	2.08	2.30	12.26	1.29
8.81	9.88	4.90	4.17	70.64	71.95	2.27	2.00	11.80	1.58
9.69	10.03	3.99	5.00	71.65	70.04	2.11	2.02	11.38	1.18
9.56	10.03	3.73	5.00	71.64	70.04	1.78	2.02	12.17	1.12
9.50	10.03	4.19	5.00	72.01	70.04	1.93	2.02	11.14	1.23
9.69	10.03	4.06	5.00	69.64	70.04	1.87	2.02	13.62	1.12
9.06	10.03	3.76	5.00	71.15	70.04	1.97	2.02	12.91	1.15
8.75	10.03	3.30	5.00	72.32	70.04	1.79	2.02	12.70	1.14
8.40	10.03	3.28	5.00	73.82	70.04	1.72	2.02	11.59	1.19
8.06	10.03	3.03	5.00	71.26	70.04	1.95	2.02	14.53	1.17
8.13	10.03	3.14	5.00	71.07	70.04	1.82	2.02	14.60	1.24
8.82	10.03	4.04	5.00	69.33	70.04	2.10	2.02	14.25	1.46
9.44	10.03	3.87	5.00	71.69	70.04	1.92	2.02	11.72	1.36
9.00	10.03	4.00	5.00	73.26	70.04	2.39	2.02	10.06	1.29
9.00	10.03	3.96	5.00	71.98	70.04	2.07	2.02	11.48	1.51
8.81	10.03	3.85	5.00	73.01	70.04	2.04	2.02	11.00	1.29
8.87	10.03	4.08	5.00	71.63	70.04	2.34	2.02	11.74	1.34
9.06	10.03	4.32	5.00	73.21	70.04	1.87	2.02	10.26	1.28
8.63	10.03	3.43	5.00	73.97	70.04	1.71	2.02	11.06	1.20
8.38	10.03	3.38	5.00	73.76	70.04	1.82	2.02	11.48	1.18
8.69	10.03	3.63	5.00	72.63	70.04	2.03	2.02	11.53	1.49
8.25	10.03	3.09	5.00	75.20	70.04	1.72	2.02	10.58	1.16
8.75	10.03	3.95	5.00	74.12	70.04	2.04	2.02	9.70	1.44
9.69	10.03	3.95	5.00	71.98	70.04	2.05	2.02	11.00	1.33
8.31	10.03	4.23	5.00	73.41	70.04	2.13	2.02	10.64	1.28
8.81	10.03	3.72	5.00	73.08	70.04	1.72	2.02	11.19	1.48
8.09	10.03	3.06	5.00	72.83	70.04	2.58	2.02	11.63	1.81
8.88	10.03	3.27	5.00	73.63	70.04	1.78	2.02	11.04	1.40
8.31	10.03	3.13	5.00	74.62	70.04	2.17	2.02	10.34	1.43
9.94	10.03	3.90	5.00	72.01	70.04	2.07	2.02	10.36	1.75
9.38	10.03	3.75	5.00	71.60	70.04	2.07	2.02	11.64	1.56
8.90	10.03	3.69	5.00	72.47	70.04	1.98	2.02	11.63	1.33

CORN

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Kemper Mill and Elevator Co., Kansas City, Mo. Corn Chops	3404	1
	4076	1
	4454	3
	4649	1
	4777	1
	4847	1
	5145	1
	5309	1
	5355	2
Average		12
Kimball Fowler Co., Kansas City, Mo. Corn Chops	2490	1
Henry A. Klyce Co., Dyersburg, Tenn. Corn Chops	3985	1
	4061	3
	4173	3
	4341	1
	4353	3
	4620	4
	4711	4
	4912	3
	4958	2
	5003	2
	5065	1
	5143	1
	5201	1
	5276	4
	5307	1
	5328	3
Average		37
Levy Grocery Co., Baton Rouge, La. Corn Chops	4951	1

CHOPS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
8.56	7.40	2.80	3.40	74.21	72.25	1.82	3.25	11.54	1.07
8.87	7.40	3.75	3.40	72.47	72.25	2.00	3.25	11.64	1.27
9.13	7.40	4.22	3.40	71.51	72.25	2.51	3.25	11.29	1.34
9.50	7.40	3.51	3.40	73.27	72.25	2.01	3.25	10.53	1.18
9.94	7.40	3.50	3.40	71.47	72.25	2.18	3.25	11.43	1.48
8.94	7.40	3.61	3.40	72.46	72.25	1.97	3.25	11.91	1.11
8.44	7.40	3.63	3.40	72.06	72.25	1.85	3.25	12.49	1.53
10.19	7.40	3.86	3.40	70.16	72.25	2.44	3.25	11.80	1.55
9.94	7.40	4.42	3.40	71.43	72.25	2.17	3.25	10.45	1.59
9.28	7.40	3.70	3.40	72.12	72.25	2.10	3.25	11.45	1.35
9.81	9.88	4.04	4.17	72.60	71.95	2.21	2.00	10.00	1.34
8.13	15.01	3.06	4.09	71.01	61.84	4.14	5.10	12.17	1.49
8.12	15.01	3.52	4.09	71.49	61.84	3.48	5.10	11.80	1.59
8.75	15.01	4.28	4.09	71.81	61.84	3.82	5.10	9.55	1.79
7.75	15.01	2.85	4.09	72.99	61.84	3.41	5.10	11.03	1.97
7.81	15.01	3.34	4.09	72.59	61.84	3.62	5.10	11.29	1.35
8.06	15.01	3.40	4.09	73.36	61.84	4.02	5.10	9.88	1.28
9.06	15.01	3.75	4.09	70.88	61.84	4.10	5.10	10.81	1.40
7.41	15.01	3.14	4.09	72.96	61.84	3.89	5.10	11.28	1.32
7.25	15.01	3.11	4.09	71.32	61.84	4.46	5.10	12.56	1.30
7.63	15.01	3.36	4.09	71.35	61.84	4.45	5.10	11.60	1.61
7.44	15.01	3.22	4.09	71.67	61.84	4.45	5.10	11.76	1.46
7.63	15.01	3.13	4.09	71.66	61.84	4.39	5.10	11.73	1.46
7.13	15.01	2.58	4.09	73.12	61.84	5.38	5.10	10.26	1.53
7.75	15.01	3.41	4.09	72.25	61.84	4.51	5.10	10.44	1.64
7.81	15.01	3.16	4.09	75.39	61.84	2.41	5.10	9.72	1.51
9.31	15.01	4.39	4.09	70.33	61.84	4.11	5.10	10.10	1.76
7.94	15.01	3.36	4.09	72.14	61.84	4.04	5.10	11.00	1.52
8.88	12.00	3.89	4.00	72.94	75.00	2.11	2.00	11.02	1.16

CORN

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Louisiana Grain and Milling Co., Lake Charles, La.		
Pure Corn Chops	2211	23
	2480	3
	2604	5
	2729	2
	2788	2
	2845	3
	2998	1
	3096	1
	3137	1
	3280	2
	3494	1
	3589	1
	4038	1
	4399	1
	4726	1
	2371	6
Average		54
Lukens Milling Co., Atchison, Kan.		
Corn Chops	3060	1
Marsh Commission Co., Pine Bluff, Ark.		
Corn Chops	3875	3
	4010	7
	4151	1
	4222	3
	4303	5
	4336	1
	4381	1
	4553	1
	4664	2
	4849	1
	5036	2
	5113	3
	5357	2
Average		32
McEwen Grain Co., Kansas City, Mo.		
Corn Chops	2684	1
	2850	1
	3642	1
Average		3

CHOPS.

PROTEIN		FAT		CARBOHY-DRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
9.56	8.75	3.54	3.25	72.52	75.25	1.84	1.50	11.35	1.19
10.13	8.75	4.21	3.25	69.64	75.25	1.97	1.50	12.87	1.18
9.31	8.75	3.70	3.25	72.00	75.25	1.86	1.50	11.91	1.22
8.39	8.75	3.24	3.25	71.74	75.25	1.60	1.50	13.84	1.19
8.94	8.75	3.69	3.25	71.00	75.25	1.85	1.50	13.33	1.19
8.81	8.75	3.48	3.25	70.28	75.25	1.83	1.50	14.49	1.11
8.45	8.75	2.67	3.25	71.18	75.25	1.60	1.50	14.53	1.57
8.73	8.75	3.26	3.25	70.70	75.25	1.80	1.50	14.43	1.08
8.25	8.75	2.76	3.25	70.96	75.25	1.54	1.50	15.27	1.22
8.73	8.75	3.14	3.25	71.96	75.25	1.85	1.50	13.11	1.19
9.00	8.75	3.23	3.25	71.07	75.25	1.84	1.50	13.75	1.11
8.56	8.75	3.40	3.25	70.88	75.25	1.82	1.50	14.17	1.17
8.75	8.75	3.35	3.25	71.44	75.25	1.95	1.50	13.23	1.28
8.56	8.75	3.44	3.25	72.63	75.25	1.75	1.50	12.38	1.24
8.56	8.75	3.13	3.25	75.11	75.25	1.77	1.50	10.22	1.21
9.50	8.75	3.30	3.25	72.92	75.25	1.92	1.50	11.21	1.15
8.88	8.75	3.34	3.25	71.62	75.25	1.80	1.50	13.16	1.20
9.25	7.50	3.55	3.00	72.35	65.00	2.53	5.00	10.83	1.49
9.19	8.00	4.82	4.50	70.33	73.00	2.65	2.00	10.40	2.61
9.81	8.00	3.83	4.50	71.53	73.00	2.15	2.00	11.37	1.31
10.56	8.00	4.27	4.50	70.27	73.00	2.32	2.00	11.32	1.26
9.94	8.00	4.20	4.50	71.13	73.00	1.92	2.00	11.42	1.39
9.50	8.00	4.07	4.50	71.79	73.00	2.03	2.00	11.22	1.39
10.63	8.00	4.13	4.50	70.92	73.00	2.16	2.00	10.77	1.39
10.63	8.00	3.98	4.50	70.34	73.00	2.04	2.00	11.64	1.37
8.63	8.00	3.01	4.50	74.05	73.00	1.86	2.00	11.31	1.14
8.81	8.00	3.32	4.50	72.60	73.00	2.46	2.00	11.32	1.49
9.44	8.00	3.73	4.50	73.72	73.00	1.95	2.00	9.82	1.34
8.63	8.00	4.13	4.50	72.43	73.00	2.37	2.00	11.06	1.38
8.44	8.00	3.58	4.50	72.87	73.00	2.00	2.00	11.69	1.42
8.13	8.00	2.74	4.50	74.53	73.00	1.73	2.00	11.40	1.47
9.44	8.00	3.83	4.50	72.04	73.00	2.12	2.00	11.13	1.44
9.41	13.00	3.72	4.04	71.92	69.26	2.15	2.80	11.51	1.29
8.58	13.00	3.06	4.04	70.14	69.26	1.96	2.80	14.94	1.32
9.00	13.00	2.81	4.04	71.74	69.26	1.74	2.80	13.53	1.20
9.00	13.00	3.19	4.04	71.26	69.26	1.95	2.80	13.33	1.27

CHOPS.

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
McGregor Milling and Grain Co., McGregor, Tex.		
Corn Chops	5310	1
Midland Mill and Elevator Co., Muscogee, Okla.		
Masoto Corn Chops	3179	1
	3394	4
	3480	1
	3684	1
	3758	4
	3823	3
	3900	6
	3967	7
	4264	2
	4297	9
	4355	3
	4455	2
	4522	4
	4833	1
	2810	2
	4167	2
	4279	2
	5363	1
Average		55
O K Corn Chops	4319	1
Josey Miller Co., Beaumont, Tex.		
Corn Chops	2255	2
	2557	3
	2830	2
	3660	3
	3903	1
	3927	2
	3933	1
	4369	1
	4618	4
	5221	1
Average		20

CHOPS.

PROTEIN		FAT		CARBOHY-DRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
10.13	9.50	3.34	3.50	70.03	58.00	3.22	5.00	11.13	2.15
9.06	10.20	3.63	2.50	70.67	73.00	1.99	3.00	13.44	1.21
9.93	10.20	3.44	2.50	73.43	73.00	2.16	3.00	9.79	1.25
10.56	10.20	4.25	2.50	69.71	73.00	2.07	3.00	12.02	1.39
9.69	10.20	3.67	2.50	70.98	73.00	2.39	3.00	12.07	1.20
10.19	10.20	3.94	2.50	71.23	73.00	2.28	3.00	11.04	1.32
8.77	10.20	4.13	2.50	71.74	73.00	2.40	3.00	11.55	1.41
10.56	10.20	4.34	2.50	71.10	73.00	2.21	3.00	10.33	1.46
10.00	10.20	4.55	2.50	70.23	73.00	2.23	3.00	11.39	1.60
10.44	10.20	4.10	2.50	71.77	73.00	2.39	3.00	10.14	1.16
9.87	10.20	4.24	2.50	72.30	73.00	2.38	3.00	9.82	1.39
10.25	10.20	4.05	2.50	70.61	73.00	2.43	3.00	11.22	1.44
10.13	10.20	3.37	2.50	71.39	73.00	2.28	3.00	11.52	1.31
8.81	10.20	4.21	2.50	72.82	73.00	2.37	3.00	10.31	1.48
8.94	10.20	3.08	2.50	73.97	73.00	2.27	3.00	10.64	1.10
9.59	10.20	4.01	2.50	70.80	73.00	2.15	3.00	12.21	1.24
9.87	10.20	4.89	2.50	71.15	73.00	2.45	3.00	10.17	1.47
10.69	10.20	4.14	2.50	70.83	73.00	2.55	3.00	10.34	1.45
8.94	10.20	3.77	2.50	73.45	73.00	3.65	3.00	8.60	1.59
9.79	10.20	3.99	2.50	71.57	73.00	2.37	3.00	10.92	1.36
10.13	9.00	4.62	3.00	69.07	65.00	2.54	4.00	12.06	1.58
10.00	9.00	4.37	4.00	70.18	70.00	2.40	2.00	11.57	1.48
9.50	9.00	4.10	4.00	72.89	70.00	2.31	2.00	9.74	1.46
9.44	9.00	3.97	4.00	70.65	70.00	2.31	2.00	12.30	1.33
9.19	9.00	3.35	4.00	71.87	70.00	2.12	2.00	12.15	1.32
9.38	9.00	3.94	4.00	70.75	70.00	3.64	2.00	10.05	2.24
10.06	9.00	3.62	4.00	72.11	70.00	2.06	2.00	10.72	1.43
9.13	9.00	3.27	4.00	72.07	70.00	2.73	2.00	11.11	1.69
8.56	9.00	2.91	4.00	73.54	70.00	2.32	2.00	11.25	1.42
10.50	9.00	3.90	4.00	71.28	70.00	2.58	2.00	10.11	1.63
9.13	9.00	3.25	4.00	72.57	70.00	2.99	2.00	10.28	1.78
9.49	9.00	3.67	4.00	71.79	70.00	2.54	2.00	10.93	1.58

CORN

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Missouri and Kansas Grain Co., Neosho, Mo.		
Corn Chops	2218	7
	2432	8
	2526	11
	2610	5
	2689	2
	2798	3
	2828	11
	2886	5
	2993	1
	3097	1
	3160	6
	3393	4
	3562	9
	3609	7
	3717	1
	3787	2
	3826	4
	3892	6
	3956	2
	4195	1
	4298	1
	4388	1
	4530	3
	4616	5
	4744	1
	4755	5
	5005	7
	5010	3
	5169	3
	5212	9
	5335	6
Average		146
Nelson Grain Co., Kansas City, Mo.		
Pure Corn Chops	2258	2
	2363	9
	2455	18
	2527	2
	2727	2
	2784	3
	2876	31
	3022	2
	3075	7

CHOPS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
8.81	10.00	3.26	3.50	73.44	53.00	1.67	10.00	11.80	1.02
9.06	10.00	3.58	3.50	72.64	53.00	2.19	10.00	11.13	1.40
9.73	10.00	3.52	3.50	73.00	53.00	2.03	10.00	10.54	1.18
9.44	10.00	4.00	3.50	73.20	53.00	2.07	10.00	10.08	1.21
8.94	10.00	3.87	3.50	72.02	53.00	1.87	10.00	12.09	1.21
9.04	10.00	3.35	3.50	73.09	53.00	1.90	10.00	11.47	1.15
8.94	10.00	3.46	3.50	71.49	53.00	1.78	10.00	13.16	1.17
9.06	10.00	4.01	3.50	72.27	53.00	2.01	10.00	11.37	1.28
9.31	10.00	3.79	3.50	71.39	53.00	2.11	10.00	12.11	1.29
8.75	10.00	3.38	3.50	72.51	53.00	1.89	10.00	12.35	1.12
8.88	10.00	3.29	3.50	72.45	53.00	1.95	10.00	12.14	1.29
10.50	10.00	4.38	3.50	71.90	53.00	2.25	10.00	9.74	1.23
8.63	10.00	3.68	3.50	72.66	53.00	2.07	10.00	11.75	1.21
8.63	10.00	3.42	3.50	74.03	53.00	1.79	10.00	10.96	1.17
8.56	10.00	3.46	3.50	73.33	53.00	1.74	10.00	11.82	1.09
9.19	10.00	4.18	3.50	71.67	53.00	2.24	10.00	11.22	1.50
9.63	10.00	4.90	3.50	69.76	53.00	2.53	10.00	11.56	1.62
9.13	10.00	4.11	3.50	73.19	53.00	2.07	10.00	10.34	1.16
8.94	10.00	4.29	3.50	71.96	53.00	2.19	10.00	11.30	1.32
9.69	10.00	4.74	3.50	69.80	53.00	2.53	10.00	11.74	1.50
8.88	10.00	3.73	3.50	74.28	53.00	2.12	10.00	9.87	1.12
8.88	10.00	4.66	3.50	72.06	53.00	2.71	10.00	10.20	1.49
8.56	10.00	3.43	3.50	73.13	53.00	1.86	10.00	11.67	1.35
8.75	10.00	3.79	3.50	73.84	53.00	2.14	10.00	10.30	1.18
9.06	10.00	3.84	3.50	72.39	53.00	2.01	10.00	11.39	1.31
9.00	10.00	4.22	3.50	71.57	53.00	2.31	10.00	11.51	1.39
8.69	10.00	3.61	3.50	73.97	53.00	1.95	10.00	10.55	1.23
9.19	10.00	3.72	3.50	73.01	53.00	2.01	10.00	10.59	1.48
8.81	10.00	4.78	3.50	70.67	53.00	2.48	10.00	11.37	1.89
8.19	10.00	3.20	3.50	73.40	53.00	2.25	10.00	11.45	1.51
8.88	10.00	4.05	3.50	74.41	53.00	2.38	10.00	8.93	1.35
9.02	10.00	3.86	3.50	72.54	53.00	2.10	10.00	11.18	1.30
9.44	8.01	3.33	5.00	72.44	72.07	1.75	2.00	11.89	1.15
9.44	8.01	4.21	5.00	72.05	72.07	2.17	2.00	10.91	1.22
9.63	8.01	3.59	5.00	73.75	72.07	1.92	2.00	9.69	1.42
9.44	8.01	3.69	5.00	74.21	72.07	2.13	2.00	9.19	1.34
9.19	8.01	3.91	5.00	71.70	72.07	2.05	2.00	11.84	1.31
9.13	8.01	4.46	5.00	70.33	72.07	2.16	2.00	12.49	1.43
9.56	8.01	3.56	5.00	73.00	72.07	1.92	2.00	10.67	1.29
8.88	8.01	3.81	5.00	72.13	72.07	1.83	2.00	12.14	1.21
9.19	8.01	4.16	5.00	69.90	72.07	2.05	2.00	13.41	1.29

CORN

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Nelson Grain Co.—Continued.		
	3107	5
	3183	2
	3214	8
	3323	2
	3402	1
	3463	9
	3543	6
	3605	8
	3666	10
	3730	8
	3786	3
	3898	6
	3955	2
	4126	1
	4224	2
	4345	1
	4390	1
	4440	7
	4491	2
	4509	6
	4561	1
	4679	3
	4725	1
	4757	8
	4783	16
	4835	2
	4866	2
	4965	3
	5019	7
	5117	7
	5194	1
	5210	3
	5251	1
	5274	8
	5329	3
	5416	1
	5463	1
Average		235
Pure Corn Chops	5339	5

CHOPS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
9.13	8.01	4.03	5.00	70.06	72.07	2.00	2.00	13.53	1.25
9.25	8.01	4.15	5.00	71.18	72.07	2.13	2.00	11.97	1.32
9.44	8.01	3.57	5.00	72.19	72.07	1.88	2.00	11.62	1.30
8.58	8.01	3.43	5.00	74.18	72.07	1.74	2.00	10.88	1.19
9.19	8.01	4.02	5.00	71.86	72.07	2.18	2.00	11.46	1.29
8.56	8.01	3.65	5.00	72.45	72.07	1.95	2.00	12.16	1.23
8.88	8.01	3.94	5.00	72.92	72.07	2.11	2.00	10.79	1.36
9.06	8.01	3.92	5.00	72.63	72.07	1.88	2.00	11.29	1.22
8.94	8.01	4.00	5.00	70.89	72.07	2.09	2.00	12.73	1.35
8.94	8.01	3.98	5.00	72.32	72.07	2.17	2.00	11.15	1.44
8.31	8.01	3.30	5.00	72.74	72.07	2.66	2.00	11.46	1.53
9.00	8.01	4.07	5.00	72.21	72.07	2.68	2.00	10.50	1.54
8.81	8.01	3.98	5.00	72.83	72.07	2.38	2.00	10.61	1.39
9.06	8.01	3.59	5.00	71.12	72.07	2.13	2.00	12.59	1.51
8.88	8.01	3.59	5.00	72.36	72.07	2.21	2.00	11.63	1.33
8.88	8.01	4.15	5.00	73.39	72.07	2.17	2.00	10.00	1.41
8.56	8.01	4.31	5.00	73.04	72.07	2.15	2.00	10.44	1.50
9.00	8.01	3.80	5.00	71.10	72.07	2.22	2.00	12.38	1.50
8.88	8.01	3.82	5.00	71.76	72.07	2.47	2.00	11.55	1.52
8.56	8.01	3.63	5.00	72.75	72.07	2.78	2.00	10.95	1.33
8.69	8.01	2.53	5.00	73.84	72.07	2.79	2.00	10.58	1.57
8.56	8.01	3.54	5.00	72.93	72.07	1.81	2.00	11.97	1.19
8.13	8.01	3.46	5.00	74.38	72.07	1.89	2.00	10.86	1.28
8.81	8.01	3.57	5.00	72.87	72.07	1.83	2.00	11.47	1.45
9.19	8.01	3.63	5.00	72.89	72.07	2.24	2.00	10.68	1.37
8.75	8.01	3.69	5.00	72.79	72.07	2.26	2.00	11.26	1.25
9.00	8.01	3.83	5.00	72.17	72.07	2.52	2.00	10.92	1.56
9.69	8.01	3.47	5.00	72.28	72.07	2.60	2.00	10.56	1.40
8.88	8.01	4.19	5.00	72.46	72.07	2.53	2.00	10.40	1.54
9.19	8.01	3.71	5.00	72.98	72.07	2.14	2.00	10.96	1.02
8.06	8.01	3.96	5.00	72.06	72.07	2.01	2.00	12.28	1.63
8.94	8.01	3.00	5.00	72.95	72.07	2.28	2.00	11.52	1.31
7.94	8.01	3.69	5.00	73.62	72.07	1.86	2.00	11.54	1.35
8.88	8.01	3.40	5.00	72.92	72.07	2.31	2.00	10.93	1.56
8.81	8.01	3.58	5.00	73.80	72.07	2.25	2.00	10.17	1.39
9.59	8.01	4.69	5.00	71.41	72.07	2.42	2.00	10.20	1.69
8.63	8.01	3.69	5.00	73.54	72.07	2.28	2.00	10.41	1.45
8.97	8.01	3.75	5.00	72.46	72.07	2.17	2.00	11.27	1.37
9.13	8.01	3.85	3.50	73.27	72.07	2.33	2.00	9.86	1.56

CORN

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Nutriline Milling Co., Crowley, La.		
Pure Corn Chops	2929	2
	3027	1
	3071	5
	3140	1
	3243	3
	3332	6
	3467	6
	3607	4
	3701	6
	3788	2
	3845	3
	3922	3
	3970	2
	4026	4
	4140	1
	4208	7
	4233	7
	4356	7
	4401	4
	4429	5
	4526	2
	4579	2
	4718	5
	4818	1
	4890	2
	4941	2
	5080	3
	5112	4
	5290	1
	5342	5
Average		106
Pearl Roller Mills, Oswego, Kan.		
Corn Chops	2492	1
	3226	1
	3446	1
	3563	1
	3626	1
	4465	1
Average		6

CORN

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
8.88	9.00	3.42	3.00	73.35	69.00	1.71	4.00	11.60	1.04
8.41	9.00	3.85	3.00	71.13	69.00	1.80	4.00	13.62	1.19
8.75	9.00	3.37	3.00	72.12	69.00	1.71	4.00	12.95	1.10
8.44	9.00	3.22	3.00	73.41	69.00	1.72	4.00	12.05	1.16
9.13	9.00	3.60	3.00	69.59	69.00	2.46	4.00	14.06	1.16
9.13	9.00	3.40	3.00	72.04	69.00	1.74	4.00	12.46	1.23
9.25	9.00	3.45	3.00	71.53	69.00	1.68	4.00	12.90	1.19
9.19	9.00	3.59	3.00	72.66	69.00	1.89	4.00	11.48	1.19
8.94	9.00	3.51	3.00	73.01	69.00	1.95	4.00	11.40	1.19
8.88	9.00	3.37	3.00	73.47	69.00	1.79	4.00	11.29	1.20
8.94	9.00	3.76	3.00	72.01	69.00	1.96	4.00	12.05	1.28
8.94	9.00	3.67	3.00	72.41	69.00	1.91	4.00	11.73	1.34
9.44	9.00	3.71	3.00	72.25	69.00	1.96	4.00	11.36	1.28
9.50	9.00	3.53	3.00	73.22	69.00	1.85	4.00	10.68	1.22
9.00	9.00	3.65	3.00	71.17	69.00	2.03	4.00	12.97	1.18
9.00	9.00	3.27	3.00	73.00	69.00	1.95	4.00	11.60	1.17
9.94	9.00	4.26	3.00	72.48	69.00	1.97	4.00	10.03	1.32
9.75	9.00	4.29	3.00	71.23	69.00	2.09	4.00	11.21	1.43
9.00	9.00	3.48	3.00	73.26	69.00	1.92	4.00	11.07	1.27
8.63	9.00	3.79	3.00	73.21	69.00	2.04	4.00	10.94	1.39
8.63	9.00	3.47	3.00	74.35	69.00	1.90	4.00	10.40	1.25
8.75	9.00	3.74	3.00	71.87	69.00	2.13	4.00	12.18	1.33
8.75	9.00	3.39	3.00	73.90	69.00	1.96	4.00	10.79	1.21
9.25	9.00	3.50	3.00	75.22	69.00	1.77	4.00	8.99	1.27
9.00	9.00	3.66	3.00	73.22	69.00	1.90	4.00	11.01	1.21
8.31	9.00	3.11	3.00	74.31	69.00	1.93	4.00	11.18	1.16
8.81	9.00	3.85	3.00	72.00	69.00	2.10	4.00	11.88	1.36
8.00	9.00	3.15	3.00	74.51	69.00	1.83	4.00	11.10	1.41
9.56	9.00	4.13	3.00	73.91	69.00	1.91	4.00	9.15	1.34
9.38	9.00	3.68	3.00	73.75	69.00	1.92	4.00	9.94	1.33
8.99	9.00	3.60	3.00	72.79	69.00	1.91	4.00	11.47	1.24
9.69	8.00	3.28	3.25	74.19	72.98	1.99	1.62	9.57	1.28
8.69	8.00	3.52	3.25	70.83	72.98	1.72	1.62	13.99	1.25
9.19	8.00	3.73	3.25	72.33	72.98	1.94	1.62	11.43	1.38
8.81	8.00	4.00	3.25	71.54	72.98	2.01	1.62	12.30	1.34
9.63	8.00	4.31	3.25	70.23	72.98	2.39	1.62	11.88	1.56
10.50	8.00	3.52	3.25	72.80	72.98	1.95	1.62	9.92	1.31
9.42	8.00	3.72	3.25	71.99	72.98	2.00	1.62	11.52	1.35

CORN

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Pittman and Harrison Co., Sherman, Tex.		
Corn Chops	2318	1
Wm. Pollock Mill and Elevator Co., Hammond, La.		
Pure Corn Chops	5048	1
	5311	1
Average		2
Roanoke Mercantile Co., Roanoke, La.		
Pure Corn Chops	3428	1
	3752	1
	3852	1
	3986	1
	4488	1
Average		5
Russell Grain Co., Kansas City, Mo.		
Square Deal Pure Corn Chops	2457	1
	2704	1
	4037	1
	4258	1
	4482	1
Average		5
Scott County Milling Co., Sikeston and Oran, Mo.		
Corn Chops	2426	1
	2569	3
	2761	2
	3033	2
	3139	1
	3518	2
	3700	2
	3778	2
	3847	2
	4094	2
	4268	1
	4394	1
	4457	2

CHOPS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
10.69	9.00	4.46	3.30	69.58	68.00	2.18	3.00	11.35	1.74
8.88	7.50	3.68	3.10	74.10	70.00	2.18	5.00	9.85	1.31
8.69	7.50	3.81	3.10	73.01	70.00	1.81	5.00	11.41	1.27
8.79	7.50	3.75	3.10	73.55	70.00	1.99	5.00	10.63	1.29
8.44	8.00	3.50	3.00	71.98	72.00	1.95	6.00	12.80	1.33
9.19	8.00	3.59	3.00	70.27	72.00	1.90	6.00	13.70	1.35
8.81	8.00	3.89	3.00	71.25	72.00	2.03	6.00	12.66	1.36
8.94	8.00	4.01	3.00	70.96	72.00	1.99	6.00	12.82	1.28
8.56	8.00	3.77	3.00	70.93	72.00	2.08	6.00	13.15	1.51
8.80	8.00	3.75	3.00	71.08	72.00	1.99	6.00	13.03	1.35
9.38	8.02	4.15	4.03	71.53	73.07	2.24	2.00	11.41	1.29
9.16	8.02	4.26	4.03	71.85	73.07	2.10	2.00	11.25	1.38
9.13	8.02	3.55	4.03	72.27	73.07	1.82	2.00	12.07	1.16
9.25	8.02	3.43	4.03	74.05	73.07	1.98	2.00	10.08	1.21
8.63	8.02	4.06	4.03	72.51	73.07	2.50	2.00	10.96	1.34
9.11	8.02	3.89	4.03	72.44	73.07	2.13	2.00	11.15	1.28
9.56	8.70	3.82	4.55	71.49	73.12	1.87	1.83	12.10	1.16
9.19	8.70	3.98	4.55	72.19	73.12	1.91	1.83	11.53	1.20
9.38	8.70	4.16	4.55	71.47	73.12	1.85	1.83	11.86	1.28
9.13	8.70	3.87	4.55	71.71	73.12	1.63	1.83	12.37	1.29
8.75	8.70	3.19	4.55	70.82	73.12	1.70	1.83	14.20	1.34
9.00	8.70	3.74	4.55	71.98	73.12	2.07	1.83	11.91	1.30
9.25	8.70	3.66	4.55	72.48	73.12	1.78	1.83	11.53	1.30
9.56	8.70	4.21	4.55	72.00	73.12	1.83	1.83	10.99	1.41
9.38	8.70	4.17	4.55	71.18	73.12	1.89	1.83	12.03	1.35
9.69	8.70	4.75	4.55	70.46	73.12	2.70	1.83	10.82	1.58
9.00	8.70	4.00	4.55	72.45	73.12	2.24	1.83	10.83	1.48
9.25	8.70	3.14	4.55	74.50	73.12	1.84	1.83	9.90	1.37
9.44	8.70	4.55	4.55	71.76	73.12	2.50	1.83	10.26	1.49

CORN

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Scott County Milling Co.—Continued.		
	4628	2
	4669	2
	4702	2
	4893	3
	5096	1
Average		33
Seneca Mill and Elevator Co., Seneca, Mo.		
Corn Chops	2473	2
	2928	1
	4851	1
Average		4
Smith Bros.' Grain Co., Fort Worth, Tex.		
Panther Brand Pure Corn Chops	2619	1
	3847	1
	3403	1
	3886	3
	3953	1
	4329	2
	5233	1
	5316	8
	5353	3
	5389	2
Average		23
Southern Grain Co., Kansas City, Mo.		
Corn Chops	2448	5
	2634	4
	2834	1
	2914	3
	3000	1
	3057	2
	3244	3
	3337	4
	3516	3
	3650	5
	3774	2

CHOPS.

PROTEIN		FAT		CARBOHY-DRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
9.13	8.70	3.49	4.55	72.98	73.12	1.97	1.83	10.97	1.46
9.50	8.70	4.08	4.55	71.95	73.12	2.39	1.83	10.62	1.46
9.13	8.70	3.78	4.55	73.12	73.12	2.02	1.83	10.39	1.56
9.25	8.70	4.01	4.55	73.97	73.12	1.87	1.83	9.47	1.43
8.63	8.70	3.34	4.55	73.62	73.12	1.78	1.83	11.41	1.22
—	—	—	—	—	—	—	—	—	—
9.22	8.70	3.89	4.55	72.24	73.12	1.99	1.83	11.29	1.37
9.63	8.75	4.24	5.02	71.85	70.63	2.09	1.95	10.94	1.25
9.75	8.75	4.44	5.02	71.34	70.63	1.81	1.95	11.49	1.17
9.25	8.75	3.51	5.02	73.70	70.63	1.81	1.95	10.38	1.35
—	—	—	—	—	—	—	—	—	—
9.54	8.75	4.06	5.02	72.30	70.63	1.90	1.95	10.94	1.26
10.76	9.25	4.39	4.14	71.75	69.21	2.23	3.96	9.66	1.21
10.25	9.25	4.26	4.14	69.06	69.21	2.09	3.96	13.18	1.16
9.93	9.25	3.92	4.14	71.33	69.21	2.00	3.96	11.24	1.58
10.63	9.25	3.78	4.14	71.45	69.21	2.19	3.96	10.64	1.31
9.19	9.25	3.50	4.14	72.69	69.21	1.79	3.96	11.52	1.31
9.94	9.25	3.67	4.14	71.89	69.21	2.09	3.96	10.96	1.45
10.31	9.25	3.55	4.14	71.74	69.21	2.11	3.96	10.71	1.58
10.25	9.25	4.67	4.14	70.06	69.21	2.32	3.96	11.17	1.53
9.19	9.25	3.43	4.14	72.16	69.21	1.90	3.96	11.91	1.41
9.13	9.25	4.25	4.14	72.94	69.21	2.35	3.96	9.75	1.58
—	—	—	—	—	—	—	—	—	—
9.98	9.25	3.94	4.14	71.50	69.21	2.10	3.96	11.07	1.41
9.50	9.04	3.68	3.06	73.14	72.03	2.04	2.03	10.41	1.23
9.25	9.04	3.77	3.06	70.82	72.03	2.67	2.03	12.30	1.19
9.56	9.04	4.93	3.06	66.58	72.03	2.12	2.03	15.52	1.29
9.44	9.04	3.88	3.06	71.08	72.03	2.23	2.03	12.10	1.27
9.00	9.04	3.42	3.06	71.39	72.03	1.93	2.03	13.12	1.14
8.88	9.04	3.50	3.06	73.58	72.03	2.14	2.03	10.73	1.17
8.75	9.04	3.12	3.06	71.64	72.03	1.76	2.03	13.54	1.19
8.90	9.04	3.90	3.06	71.14	72.03	2.00	2.03	12.67	1.39
9.44	9.04	3.91	3.06	71.23	72.03	2.28	2.03	11.77	1.37
8.38	9.04	3.54	3.06	72.71	72.03	1.70	2.03	12.53	1.14
9.25	9.04	4.47	3.06	71.38	72.03	1.90	2.03	11.65	1.35

CORN

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Southern Grain Co.—Continued.		
	3849	3
	3921	3
	4030	2
	4127	1
	4237	3
	4360	4
	4544	1
	4572	2
	4678	2
	4820	1
	4850	1
	5084	1
	5135	2
	5242	2
Average		61
Stanard-Tilton Grain Co., Dallas, Tex.		
Corn Chops	3782	1
	4220	1
	4316	1
	4480	1
	4549	1
	4568	3
	4648	1
	5132	2
	5461	1
Average		12
Corn Chops	2522	1
	3024	1
	3275	2
	3485	1
Average		5
Stark Grain Co., Plano, Tex., and Texarkana, Ark.		
Horse Shoe Corn Chops	2395	7
	2580	1
	4344	1

CHOPS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
9.13	9.04	4.19	3.06	71.45	72.03	2.09	2.03	11.86	1.28
8.63	9.04	3.13	3.06	72.57	72.03	1.85	2.03	12.58	1.24
9.87	9.04	4.18	3.06	71.95	72.03	1.94	2.03	10.75	1.31
8.56	9.04	3.43	3.06	72.00	72.03	2.03	2.03	12.82	1.16
8.88	9.04	3.86	3.06	73.26	72.03	2.16	2.03	10.58	1.26
8.44	9.04	3.22	3.06	73.94	72.03	1.75	2.03	11.59	1.06
8.88	9.04	3.53	3.06	73.25	72.03	1.83	2.03	11.25	1.26
9.13	9.04	4.53	3.06	72.36	72.03	2.06	2.03	10.58	1.34
9.13	9.04	4.83	3.06	71.06	72.03	2.38	2.03	11.10	1.50
8.56	9.04	3.99	3.06	73.21	72.03	2.22	2.03	10.72	1.30
8.75	9.04	4.22	3.06	72.86	72.03	2.10	2.03	10.69	1.38
8.31	9.04	2.93	3.06	74.47	72.03	1.49	2.03	11.70	1.10
7.66	9.04	3.38	3.06	72.57	72.03	1.88	2.03	12.63	1.88
8.19	9.04	3.07	3.06	73.20	72.03	1.85	2.03	12.53	1.16
8.91	9.04	3.78	3.06	72.11	72.03	2.02	2.03	11.90	1.28
10.00	9.83	4.09	3.90	71.77	72.01	2.16	2.08	10.61	1.37
9.87	9.83	3.94	3.90	70.26	72.01	2.27	2.08	12.15	1.51
9.75	9.83	4.39	3.90	72.08	72.01	2.58	2.08	9.77	1.43
10.63	9.83	4.33	3.90	71.20	72.01	2.10	2.08	10.37	1.37
9.44	9.83	4.13	3.90	71.97	72.01	2.06	2.08	10.97	1.43
8.94	9.83	3.78	3.90	73.89	72.01	1.96	2.08	10.20	1.23
10.44	9.83	5.00	3.90	69.88	72.01	2.23	2.08	11.10	1.35
9.88	9.83	3.60	3.90	70.28	72.01	2.27	2.08	12.57	1.40
8.63	9.83	3.57	3.90	73.72	72.01	2.71	2.08	9.91	1.46
9.74	9.83	4.09	3.90	71.67	72.01	2.26	2.08	10.85	1.39
10.14	12.86	4.07	7.85	71.03	50.40	2.48	8.25	11.03	1.25
10.00	12.86	4.42	7.85	69.11	50.40	2.21	8.25	12.96	1.30
10.31	12.86	4.42	7.85	70.26	50.40	2.48	8.25	11.22	1.31
10.06	12.86	4.08	7.85	70.74	50.40	1.86	8.25	12.01	1.25
10.13	12.86	4.25	7.85	70.29	50.40	2.25	8.25	11.80	1.28
9.63	7.10	4.29	5.00	72.59	65.00	2.33	14.00	9.60	1.56
9.49	7.10	4.03	5.00	72.08	65.00	2.41	14.00	10.62	1.37
9.38	7.10	4.54	5.00	72.73	65.00	2.37	14.00	9.54	1.44

CORN

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Stark Grain Co.—Continued.		
	4749	1
	4546	1
Average		11
Terminal Elevators, Kansas City, Mo.		
Corn Chops	3479	1
	3719	1
	3954	1
	4025	6
Average		9
Texarkana Mill and Elevator Co., Texarkana, Ark.		
Red Ball Corn Chops	2397	13
	2623	1
	2713	4
	2833	2
	2926	1
	2983	2
	3257	1
	3438	2
	3574	2
	3611	3
	3661	3
	3771	3
	3846	4
	3882	2
	3968	5
	4155	9
	4302	6
	4352	3
	4519	6
	4753	4
	5026	13
	5134	2
	5167	1
	5264	3
	5354	3
	5429	3
Average		101

CHOPS.

PROTEIN		FAT		CARBOHY-DRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
9.00	7.10	3.76	5.00	71.90	65.00	2.32	14.00	11.47	1.55
9.00	7.10	4.16	5.00	71.73	65.00	2.16	14.00	11.52	1.43
9.30	7.10	4.16	5.00	72 20	65.00	2.32	14.00	10.55	1.47
8.88	8.60	3.37	3.44	71.54	74.90	1.87	1.66	13.23	1.11
9.44	8.60	4.49	3.44	70.78	74.90	2.00	1.66	12.00	1.29
8.25	8.60	2.65	3.44	74.55	74.90	1.54	1.66	11.94	1.07
8.38	8.60	2.53	3.44	75.46	74.90	1.52	1.66	11.10	1.01
8.74	8.60	3.26	3.44	73.08	74.90	1.73	1.66	12.07	1.12
9.69	7.10	4.85	3.00	72.67	65.00	2.21	14.00	9.29	1.29
9.71	7.10	3.87	3.00	71.65	65.00	2.02	14.00	11.50	1.25
9.69	7.10	3.89	3.00	72.42	65.00	2.09	14.00	10.77	1.14
8.75	7.10	3.02	3.00	72.73	65.00	1.68	14.00	12.79	1.03
9.00	7.10	3.57	3.00	72.38	65.00	1.70	14.00	12.20	1.15
8.69	7.10	4.15	3.00	72.79	65.00	2.28	14.00	10.84	1.25
9.00	7.10	3.81	3.00	72.86	65.00	2.24	14.00	10.70	1.39
9.00	7.10	4.46	3.00	71.10	65.00	2.38	14.00	11.49	1.57
8.75	7.10	3.98	3.00	73.33	65.00	1.73	14.00	10.91	1.30
8.88	7.10	4.73	3.00	71.91	65.00	2.19	14.00	10.75	1.54
9.44	7.10	4.30	3.00	70.70	65.00	2.57	14.00	11.64	1.35
9.13	7.10	4.01	3.00	71.99	65.00	2.20	14.00	11.26	1.41
9.19	7.10	3.95	3.00	70.95	65.00	2.41	14.00	12.16	1.34
9.63	7.10	3.94	3.00	71.87	65.00	2.33	14.00	10.90	1.33
9.69	7.10	4.24	3.00	71.10	65.00	2.29	14.00	11.30	1.38
8.94	7.10	3.76	3.00	72.38	65.00	2.40	14.00	11.27	1.25
9.13	7.10	4.09	3.00	72.00	65.00	2.61	14.00	10.83	1.34
10.13	7.10	3.85	3.00	70.37	65.00	2.46	14.00	11.78	1.41
9.13	7.10	3.81	3.00	72.29	65.00	2.35	14.00	10.64	1.78
8.75	7.10	3.65	3.00	72.02	65.00	2.37	14.00	11.97	1.24
8.94	7.10	4.18	3.00	71.69	65.00	2.64	14.00	11.04	1.51
8.16	7.10	4.22	3.00	70.74	65.00	2.59	14.00	12.53	1.76
9.50	7.10	4.18	3.00	71.66	65.00	1.91	14.00	11.06	1.69
9.13	7.10	4.38	3.00	71.92	65.00	2.78	14.00	10.03	1.76
9.75	7.10	4.31	3.00	69.48	65.00	3.10	14.00	11.74	1.62
9.75	7.10	4.55	3.00	71.41	65.00	2.70	14.00	9.94	1.65
9.21	7.10	4.07	3.00	71.79	65.00	2.32	14.00	11.20	1.41

CORN

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Texas Star Flour Mills, Galveston, Tex.		
Corn Chops	2257	3
	3020	1
	3447	1
	3598	1
Average		6
S. R. Washer Grain Co., Atchison, Kan.		
Washer Corn Chops	2396	6
	2520	1
	2575	2
	2696	5
	2774	1
	2881	7
	2985	2
	3058	3
	3138	1
	3245	6
	3514	2
	3772	4
	3928	3
	4003	1
	4157	4
	4271	1
	4308	9
	4518	6
	4562	1
	4705	2
	4752	3
	4857	3
	4907	1
	4959	2
	5020	8
	5136	2
	5175	2
Average		88
Weathers Grain Co., Greenville, Tex.		
Pure Corn Chops	5434	1

CHOPS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
9.93	9.47	4.54	3.85	70.17	69.12	2.43	3.44	11.58	1.35
10.38	9.47	4.15	3.85	69.78	69.12	2.63	3.44	11.77	1.29
10.38	9.47	4.27	3.85	68.75	69.12	3.02	3.44	12.02	1.56
10.38	9.47	4.07	3.85	68.69	69.12	3.00	3.44	12.14	1.72
—	—	—	—	—	—	—	—	—	—
10.26	9.47	4.26	3.85	69.35	69.12	2.77	3.44	11.88	1.48
10.06	8.00	4.45	4.00	71.62	55.50	2.14	5.50	10.42	1.31
8.93	8.00	4.01	4.00	71.93	55.50	2.20	5.50	11.54	1.39
9.38	8.00	3.77	4.00	71.34	55.50	2.02	5.50	12.24	1.25
9.06	8.00	3.80	4.00	70.80	55.50	1.88	5.50	13.30	1.16
8.78	8.00	3.61	4.00	70.56	55.50	2.39	5.50	13.43	1.23
9.25	8.00	3.81	4.00	72.09	55.50	2.02	5.50	11.54	1.29
9.19	8.00	4.36	4.00	71.72	55.50	2.12	5.50	11.17	1.44
9.06	8.00	3.38	4.00	72.62	55.50	1.96	5.50	11.84	1.14
9.13	8.00	4.48	4.00	68.47	55.50	2.27	5.50	14.14	1.51
9.00	8.00	3.76	4.00	71.49	55.50	1.89	5.50	12.62	1.24
8.94	8.00	3.25	4.00	72.40	55.50	1.85	5.50	12.43	1.13
8.75	8.00	3.46	4.00	74.58	55.50	1.69	5.50	10.43	1.09
8.88	8.00	3.57	4.00	73.24	55.50	2.07	5.50	10.99	1.25
9.44	8.00	3.84	4.00	72.14	55.50	2.17	5.50	10.91	1.50
8.75	8.00	3.98	4.00	73.03	55.50	2.10	5.50	10.96	1.18
9.06	8.00	3.51	4.00	74.23	55.50	1.95	5.50	9.89	1.36
8.69	8.00	3.99	4.00	72.65	55.50	2.13	5.50	11.23	1.31
8.50	8.00	3.26	4.00	74.44	55.50	1.90	5.50	10.79	1.11
8.94	8.00	3.51	4.00	71.90	55.50	2.04	5.50	12.37	1.24
8.44	8.00	4.14	4.00	72.80	55.50	2.29	5.50	10.99	1.34
8.44	8.00	3.67	4.00	73.70	55.50	1.92	5.50	11.01	1.26
8.50	8.00	3.27	4.00	72.98	55.50	2.16	5.50	11.89	1.20
8.69	8.00	2.32	4.00	73.87	55.50	1.86	5.50	12.23	1.03
10.13	8.00	4.34	4.00	69.31	55.50	2.82	5.50	11.82	1.58
8.56	8.00	2.97	4.00	74.63	55.50	1.91	5.50	10.57	1.36
8.25	8.00	3.12	4.00	71.53	55.50	2.26	5.50	13.41	1.43
9.63	8.00	4.57	4.00	70.91	55.50	2.16	5.50	11.08	1.65
—	—	—	—	—	—	—	—	—	—
8.98	8.00	3.71	4.00	72.27	55.50	2.08	5.50	11.68	1.28
10.13	9.00	6.12	3.00	70.65	70.00	2.89	3.00	8.33	1.88

CORN

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Webb and Maury, Memphis, Tenn.		
Corn Chops	2823	1
	2951	2
	3180	1
	3285	3
	3390	3
	3663	2
	4864	3
	5374	1
	5449	1
Average		17
Woolsey-Stahl Hay Co., Kansas City, Kan.		
Corn Chops	2670	6
	2955	2
	3052	1
	3106	4
	4058	2
Average		15
Valley Milling Co., St. Louis, Mo.		
Cracked Corn and Corn Chops	3889	4
	4075	1
	4805	1
Average		6
Yukon Mill and Grain Co., Yukon, Okla.		
Chops	4176	1

CORN AND

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
American Cereal Co., Cedar Rapids, Iowa.		
Victor Corn and Oats	2268	1
	3038	2
	3156	4
	3273	3
	3425	2

CHOPS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
9.00	8.03	4.16	3.00	69.96	65.00	1.76	3.50	13.89	1.23
8.94	8.03	3.36	3.00	73.03	65.00	1.71	3.50	11.69	1.27
9.50	8.03	4.38	3.00	69.71	65.00	2.10	3.50	12.98	1.33
9.13	8.03	4.24	3.00	72.30	65.00	1.97	3.50	10.95	1.41
8.94	8.03	4.01	3.00	72.49	65.00	2.12	3.50	11.19	1.25
8.88	8.03	3.64	3.00	72.38	65.00	2.41	3.50	11.29	1.40
8.88	8.03	3.48	3.00	73.76	65.00	2.04	3.50	10.59	1.25
9.31	8.03	3.74	3.00	74.28	65.00	2.10	3.50	9.20	1.37
8.38	8.03	3.94	3.00	72.28	65.00	2.52	3.50	11.27	1.61
9.01	8.03	3.93	3.00	72.24	65.00	2.08	3.50	11.40	1.34
8.63	8.20	3.40	5.00	73.12	70.90	1.90	2.50	11.81	1.14
9.31	8.20	3.62	5.00	71.47	70.90	2.34	2.50	11.72	1.54
9.19	8.20	3.79	5.00	69.29	70.90	2.28	2.50	14.13	1.32
8.63	8.20	3.29	5.00	70.97	70.90	1.82	2.50	14.20	1.09
9.00	8.20	3.95	5.00	70.67	70.90	2.20	2.50	12.76	1.42
8.95	8.20	3.61	5.00	71.11	70.90	2.11	2.50	12.92	1.30
9.25	11.00	3.27	4.50	73.41	70.00	2.14	2.00	10.78	1.15
8.69	11.00	3.94	4.50	71.96	70.00	2.08	2.00	11.85	1.48
9.31	11.00	3.65	4.50	74.71	70.00	1.68	2.00	9.59	1.06
9.08	11.00	3.62	4.50	73.36	70.00	1.97	2.00	10.74	1.23
10.38	11.07	3.99	4.08	70.64	69.28	2.15	1.91	11.18	1.66

OAT FEEDS.

8.44	7.50	3.26	3.00	65.64	62.00	8.72	12.00	10.53	3.41
8.31	7.50	3.20	3.00	62.68	62.00	12.33	12.00	9.97	3.51
8.50	7.50	3.29	3.00	62.29	62.00	11.93	12.00	10.89	3.10
9.44	7.50	3.23	3.00	61.39	62.00	12.14	12.00	10.30	3.50
8.00	7.50	3.24	3.00	62.92	62.00	12.25	12.00	10.22	3.37

CORN AND

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
American Cereal Co.—Continued.		
	3766	1
	3842	3
	3883	2
	4066	3
	4209	2
	4442	5
	4524	2
	4622	4
	4766	1
	4863	4
	4955	3
	5120	1
	5238	3
Average		46
Great Western Cereal Co., Nebraska City, Neb.		
Boss Chop Feed	2512	2
	2682	1
	2883	4
	3049	1
	3294	1
	3397	2
	3541	3
	3756	3
	3831	4
	3887	3
	3973	2
	4059	3
	4107	6
	4191	10
	4294	4
	4436	9
	4558	1
	4606	1
	4652	1
	4717	6
	4773	1
	4791	4
	4853	5
	4952	4
	5018	6
	5158	1
	5437	1
Average		89

OAT FEEDS.

PROTEIN		FAT		CARBOHY-DRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
8.13	7.50	3.48	3.00	63.48	62.00	11.29	12.00	10.40	3.22
8.06	7.50	3.05	3.00	63.24	62.00	11.56	12.00	10.83	3.26
8.44	7.50	3.26	3.00	69.42	62.00	5.57	12.00	10.11	3.20
7.63	7.50	3.10	3.00	63.78	62.00	11.10	12.00	11.13	3.21
7.88	7.50	3.04	3.00	63.76	62.00	11.76	12.00	10.28	3.23
7.75	7.50	2.90	3.00	63.52	62.00	12.36	12.00	10.16	3.31
7.69	7.50	2.94	3.00	65.29	62.00	12.25	12.00	8.70	3.13
7.63	7.50	3.02	3.00	65.49	62.00	12.20	12.00	8.40	3.26
7.75	7.50	2.76	3.00	64.43	62.00	12.29	12.00	9.44	3.33
7.88	7.50	2.90	3.00	63.83	62.00	12.50	12.00	9.35	3.54
8.00	7.50	2.96	3.00	64.14	62.00	11.81	12.00	9.75	3.34
8.41	7.50	2.80	3.00	64.42	62.00	10.24	12.00	10.37	3.76
7.94	7.50	2.62	3.00	64.25	62.00	11.08	12.00	10.66	3.45
8.10	7.50	3.06	3.00	64.11	62.00	11.30	12.00	10.08	3.35
9.25	8.00	5.37	3.50	62.22	62.00	10.12	11.00	9.05	3.90
8.50	8.00	4.51	3.50	62.82	62.00	10.18	11.00	10.36	3.63
8.88	8.00	4.68	3.50	63.95	62.00	10.23	11.00	8.91	3.35
9.13	8.00	4.70	3.50	64.67	62.00	8.00	11.00	9.83	3.67
8.81	8.00	4.62	3.50	65.01	62.00	9.02	11.00	9.16	3.38
9.38	8.00	5.03	3.50	63.84	62.00	8.50	11.00	9.45	3.80
8.75	8.00	4.39	3.50	63.91	62.00	9.14	11.00	9.90	3.91
8.50	8.00	4.70	3.50	63.65	62.00	8.55	11.00	9.84	4.76
8.56	8.00	5.20	3.50	62.45	62.00	9.68	11.00	9.42	4.69
8.69	8.00	5.33	3.50	61.66	62.00	9.70	11.00	9.44	5.18
8.94	8.00	5.10	3.50	63.56	62.00	7.91	11.00	10.33	4.16
8.69	8.00	4.06	3.50	65.53	62.00	7.24	11.00	11.41	3.07
8.69	8.00	3.72	3.50	66.31	62.00	8.48	11.00	9.56	3.24
8.38	8.00	3.81	3.50	66.21	62.00	9.43	11.00	9.10	3.07
8.06	8.00	3.15	3.50	65.64	62.00	8.40	11.00	8.69	6.06
7.94	8.00	3.37	3.50	66.29	62.00	9.39	11.00	9.42	3.60
8.06	8.00	3.32	3.50	65.78	62.00	7.99	11.00	9.59	5.26
8.06	8.00	3.02	3.50	67.66	62.00	8.54	11.00	10.16	2.56
8.13	8.00	3.44	3.50	68.99	62.00	7.61	11.00	9.03	2.80
8.38	8.00	4.54	3.50	65.08	62.00	9.03	11.00	8.95	4.02
8.50	8.00	4.87	3.50	65.72	62.00	8.47	11.00	9.55	2.89
8.75	8.00	4.39	3.50	65.72	62.00	7.80	11.00	9.40	3.94
8.63	8.00	5.50	3.50	62.19	62.00	9.05	11.00	10.36	4.27
8.88	8.00	4.84	3.50	60.50	62.00	11.72	11.00	9.60	4.46
8.69	8.00	4.79	3.50	62.27	62.00	8.92	11.00	9.78	5.55
8.13	8.00	4.23	3.50	66.14	62.00	8.62	11.00	9.49	3.39
8.44	8.00	5.23	3.50	63.40	62.00	9.69	11.00	9.27	3.97
8.59	8.00	4.44	3.50	64.49	62.00	8.94	11.00	9.59	3.95

CORN AND

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Great Western Cereal Co.—Continued.		
Durham Chop Feed	2321	2
	2660	1
	2749	1
	3512	13
	3757	5
	3821	6
	4008	6
	4114	2
	4193	2
	4241	4
	4435	6
	4580	2
	4613	4
	4739	1
	4775	1
	4792	4
Average		60
Excelsior Chop Feed	2412	2
	3413	10
	3535	1
	3906	1
	3974	2
	4377	2
	4430	3
	4581	5
	4614	5
	4685	1
	4774	1
	4972	3
	5024	4
Average		40
Quaker Oats Co., Cedar Rapids, Iowa.		
Banner Feed	2237	2
	2391	2
	2511	5
	2760	3
	2807	3
	2959	2
	3056	4
	3110	3

OAT FEEDS.

PROTEIN		FAT		CARBOHY-DRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
9.25	8.00	4.99	3.50	63.15	62.00	9.04	11.00	9.14	4.43
9.25	8.00	5.55	3.50	61.12	62.00	9.43	11.00	9.66	4.99
9.19	8.00	4.90	3.50	63.36	62.00	7.93	11.00	10.64	3.98
8.69	8.00	3.69	3.50	63.69	62.00	10.30	11.00	10.28	3.35
8.81	8.00	4.62	3.50	63.63	62.00	9.20	11.00	10.12	3.62
7.50	8.00	3.15	3.50	62.91	62.00	12.48	11.00	10.64	3.32
8.81	8.00	4.91	3.50	64.32	62.00	8.63	11.00	9.69	3.64
7.94	8.00	3.35	3.50	63.81	62.00	11.94	11.00	9.25	3.71
7.44	8.00	3.02	3.50	63.69	62.00	12.66	11.00	9.83	3.36
8.25	8.00	3.52	3.50	67.56	62.00	8.30	11.00	9.46	2.91
8.06	8.00	3.57	3.50	66.67	62.00	7.38	11.00	9.79	4.53
7.75	8.00	3.56	3.50	65.36	62.00	9.83	11.00	10.23	3.27
7.81	8.00	3.52	3.50	65.32	62.00	10.29	11.00	9.73	3.33
8.19	8.00	3.80	3.50	67.40	62.00	7.44	11.00	10.61	2.56
8.44	8.00	4.81	3.50	64.18	62.00	10.24	11.00	8.17	4.16
8.13	8.00	3.64	3.50	67.48	62.00	7.07	11.00	9.15	4.53
8.34	8.00	4.04	3.50	64.61	62.00	9.51	11.00	9.77	3.73
9.31	8.00	5.03	3.50	63.63	62.00	9.88	11.00	8.81	3.34
8.88	8.00	4.93	3.50	64.19	62.00	8.43	11.00	10.18	3.39
8.88	8.00	5.16	3.50	62.66	62.00	9.03	11.00	9.59	4.68
9.44	8.00	5.40	3.50	64.32	62.00	7.10	11.00	10.28	3.46
8.63	8.00	5.33	3.50	63.23	62.00	8.85	11.00	10.19	3.77
8.06	8.00	4.10	3.50	65.47	62.00	8.79	11.00	9.72	3.86
8.19	8.00	3.58	3.50	66.53	62.00	8.78	11.00	9.28	3.64
8.26	8.00	4.30	3.50	65.29	62.00	8.99	11.00	10.28	2.88
8.31	8.00	4.15	3.50	66.21	62.00	8.99	11.00	9.51	2.83
8.75	8.00	4.33	3.50	66.12	62.00	8.77	11.00	9.12	2.91
8.31	8.00	5.00	3.50	66.09	62.00	9.08	11.00	8.49	3.03
8.06	8.00	5.12	3.50	60.10	62.00	10.23	11.00	9.95	6.54
8.81	8.00	4.45	3.50	64.03	62.00	7.54	11.00	9.93	5.24
8.61	8.00	4.68	3.50	64.46	62.00	8.80	11.00	9.64	3.81
8.75	8.00	3.49	3.50	65.76	62.00	8.97	10.00	10.25	2.78
9.44	8.00	3.69	3.50	64.16	62.00	9.10	10.00	10.89	2.72
10.00	8.00	3.10	3.50	63.38	62.00	10.11	10.00	10.27	3.14
9.40	8.00	2.97	3.50	64.53	62.00	9.63	10.00	10.38	3.09
8.94	8.00	3.07	3.50	63.19	62.00	11.25	10.00	10.26	3.29
9.44	8.00	3.02	3.50	65.09	62.00	9.16	10.00	10.20	3.09
9.69	8.00	3.62	3.50	64.05	62.00	9.46	10.00	10.07	3.11
9.25	8.00	3.43	3.50	60.98	62.00	10.69	10.00	12.46	3.19

CORN AND

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Quaker Oats Co.—Continued.		
	3188	1
	3218	6
	3343	3
	3424	5
	3488	2
	3510	9
	3561	6
	3613	6
	3668	11
	3770	8
	3783	1
	3820	6
	3884	4
	3930	4
	3966	8
	4023	14
	4097	4
	4131	8
	4227	8
	4307	5
	4380	2
	4411	5
	4450	2
	4495	5
	4536	4
	4574	2
	4594	10
	4621	5
	4699	1
	4710	8
	4761	6
	4784	9
	4860	3
	4901	1
	4956	3
	4957	1
	4964	4
	5012	2
	5131	2
	5206	3
	5236	9
	5280	3
	5344	2
	5395	9
	5413	1
Average		245

OAT FEEDS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
8.88	8.00	3.15	3.50	63.03	62.00	9.43	10.00	12.62	2.89
9.19	8.00	3.08	3.50	64.33	62.00	10.05	10.00	10.27	3.08
9.19	8.00	3.52	3.50	63.02	62.00	10.39	10.00	10.54	3.34
8.94	8.00	3.14	3.50	64.43	62.00	10.37	10.00	10.00	3.12
9.38	8.00	3.15	3.50	63.51	62.00	10.21	10.00	10.71	3.04
9.13	8.00	3.33	3.50	65.05	62.00	9.41	10.00	10.61	2.92
9.25	8.00	3.24	3.50	65.06	62.00	9.14	10.00	10.41	2.90
8.69	8.00	3.34	3.50	65.92	62.00	9.75	10.00	9.26	3.04
8.88	8.00	3.32	3.50	64.36	62.00	10.20	10.00	10.22	3.02
8.75	8.00	3.52	3.50	64.61	62.00	9.97	10.00	9.85	3.30
8.56	8.00	3.40	3.50	65.34	62.00	11.30	10.00	7.96	3.44
9.06	8.00	3.10	3.50	64.19	62.00	9.98	10.00	10.55	3.12
9.25	8.00	3.24	3.50	64.94	62.00	9.51	10.00	10.04	3.02
9.19	8.00	3.14	3.50	65.41	62.00	9.30	10.00	10.09	2.87
9.25	8.00	3.43	3.50	63.60	62.00	9.78	10.00	10.94	3.00
8.81	8.00	3.10	3.50	65.05	62.00	9.97	10.00	10.13	2.94
8.94	8.00	3.29	3.50	65.32	62.00	9.80	10.00	9.63	3.02
9.44	8.00	3.10	3.50	64.03	62.00	9.88	10.00	10.44	3.11
8.88	8.00	3.38	3.50	63.77	62.00	10.69	10.00	10.06	3.22
9.00	8.00	3.43	3.50	65.56	62.00	9.52	10.00	9.50	2.99
8.63	8.00	3.25	3.50	67.81	62.00	8.35	10.00	9.32	2.64
9.31	8.00	3.45	3.50	65.83	62.00	8.94	10.00	9.51	2.96
8.63	8.00	3.25	3.50	64.49	62.00	10.26	10.00	10.25	3.12
8.75	8.00	3.25	3.50	64.82	62.00	10.18	10.00	9.97	3.03
8.25	8.00	3.02	3.50	64.68	62.00	11.68	10.00	8.94	3.43
9.69	8.00	3.08	3.50	64.58	62.00	10.45	10.00	9.09	3.11
8.63	8.00	3.16	3.50	66.15	62.00	10.19	10.00	8.77	3.10
8.88	8.00	3.14	3.50	65.78	62.00	9.70	10.00	9.45	3.05
9.13	8.00	3.34	3.50	66.24	62.00	10.13	10.00	8.19	2.97
8.63	8.00	3.40	3.50	65.56	62.00	9.37	10.00	10.16	2.88
9.00	8.00	3.20	3.50	64.11	62.00	10.37	10.00	10.09	3.23
8.94	8.00	3.41	3.50	65.55	62.00	9.49	10.00	9.64	2.97
9.00	8.00	3.23	3.50	64.46	62.00	9.10	10.00	11.37	2.84
8.81	8.00	3.09	3.50	66.49	62.00	9.60	10.00	9.16	2.85
8.56	8.00	3.21	3.50	66.10	62.00	8.98	10.00	10.34	2.81
8.81	8.00	3.21	3.50	67.71	62.00	7.57	10.00	9.83	2.87
8.81	8.00	3.27	3.50	66.65	62.00	8.27	10.00	10.13	2.87
9.00	8.00	3.00	3.50	65.13	62.00	9.72	10.00	9.70	3.45
9.00	8.00	2.98	3.50	62.73	62.00	9.18	10.00	12.78	3.33
8.38	8.00	2.91	3.50	66.04	62.00	9.05	10.00	10.48	3.14
9.63	8.00	3.33	3.50	63.66	62.00	9.91	10.00	10.16	3.31
9.19	8.00	3.45	3.50	64.39	62.00	9.76	10.00	9.80	3.41
8.69	8.00	2.94	3.50	64.99	62.00	10.35	10.00	9.42	3.61
8.75	8.00	3.00	3.50	65.26	62.00	9.95	10.00	9.47	3.57
9.22	8.00	2.94	3.50	63.64	62.00	11.32	10.00	9.19	3.69
9.02	8.00	3.23	3.50	64.80	62.00	9.79	10.00	10.07	3.09

CORN AND

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Valley Milling Co., St. Louis, Mo.		
Delta	2252	2
	2529	2
	2786	2
	2921	1
	2954	2
	3059	1
	3117	2
	3167	4
	3414	11
	3509	6
	3551	10
	3614	4
	3731	2
	3830	6
	3891	7
	3958	5
	4022	2
	4067	5
	4099	2
	4190	10
	4238	3
	4378	2
	4413	3
	4449	2
	4492	6
	4516	4
	4595	7
	4623	5
	4680	1
	4709	3
	4781	1
	4785	7
	4862	6
	4939	1
	5037	6
	5072	2
	5114	3
	5254	1
	5324	1
	5396	4
	5472	1
Average		155
Mula	3187	1
	4165	2

OAT FEEDS.

PROTEIN		FAT		CARBOHY-DRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
8.56	7.50	3.31	4.50	67.04	59.40	8.85	14.00	9.02	3.22
8.69	7.50	3.99	4.50	64.43	59.40	10.58	14.00	9.02	3.29
9.00	7.50	3.88	4.50	66.29	59.40	8.15	14.00	10.00	2.68
9.00	7.50	4.77	4.50	64.17	59.40	9.64	14.00	9.39	3.03
8.63	7.50	3.95	4.50	64.46	59.40	10.07	14.00	9.61	3.28
8.75	7.50	4.44	4.50	62.46	59.40	10.75	14.00	10.30	3.30
8.00	7.50	3.59	4.50	61.69	59.40	9.89	14.00	12.31	4.52
8.13	7.50	4.14	4.50	63.19	59.40	10.96	14.00	9.96	3.62
8.56	7.50	4.34	4.50	63.12	59.40	10.77	14.00	9.83	3.38
9.00	7.50	4.88	4.50	62.14	59.40	11.24	14.00	9.05	3.69
8.44	7.50	4.44	4.50	63.37	59.40	9.98	14.00	10.36	3.41
8.13	7.50	4.45	4.50	62.99	59.40	11.06	14.00	9.02	4.35
8.31	7.50	4.75	4.50	62.25	59.40	11.49	14.00	9.65	3.55
8.06	7.50	4.06	4.50	63.30	59.40	11.17	14.00	9.71	3.70
8.06	7.50	3.64	4.50	60.10	59.40	15.32	14.00	8.71	4.17
8.44	7.50	4.19	4.50	62.73	59.40	11.67	14.00	9.61	3.33
8.44	7.50	4.04	4.50	61.56	59.40	12.53	14.00	9.92	3.51
8.56	7.50	4.20	4.50	62.83	59.40	10.22	14.00	10.95	3.24
8.25	7.50	4.00	4.50	62.24	59.40	12.96	14.00	8.76	3.79
8.19	7.50	4.02	4.50	63.48	59.40	11.89	14.00	8.80	3.62
8.31	7.50	4.35	4.50	63.34	59.40	11.44	14.00	9.07	3.49
8.13	7.50	3.67	4.50	62.54	59.40	12.59	14.00	9.47	3.60
8.25	7.50	4.05	4.50	63.63	59.40	11.54	14.00	8.99	3.54
8.31	7.50	3.90	4.50	64.47	59.40	11.00	14.00	8.74	3.58
8.31	7.50	3.65	4.50	62.93	59.40	11.52	14.00	10.20	3.39
7.94	7.50	3.52	4.50	64.00	59.40	12.13	14.00	8.99	3.42
8.19	7.50	4.06	4.50	64.48	59.40	11.25	14.00	8.63	3.39
8.13	7.50	3.81	4.50	66.14	59.40	10.00	14.00	8.66	3.26
8.69	7.50	4.40	4.50	64.22	59.40	8.85	14.00	10.86	2.98
9.06	7.50	3.70	4.50	62.57	59.40	11.32	14.00	10.08	3.27
8.13	7.50	3.71	4.50	65.15	59.40	10.85	14.00	9.04	3.12
7.88	7.50	3.92	4.50	62.55	59.40	12.58	14.00	9.17	3.90
8.06	7.50	4.20	4.50	63.05	59.40	11.84	14.00	9.25	3.60
7.88	7.50	3.90	4.50	62.24	59.40	13.05	14.00	8.81	4.12
8.06	7.50	3.51	4.50	63.70	59.40	11.50	14.00	9.37	3.86
8.31	7.50	3.60	4.50	62.64	59.40	11.28	14.00	10.71	3.46
7.50	7.50	3.44	4.50	63.48	59.40	11.31	14.00	10.70	3.57
8.25	7.50	2.55	4.50	64.52	59.40	10.50	14.00	10.72	3.46
7.56	7.50	3.90	4.50	60.21	59.40	11.21	14.00	13.68	3.44
7.81	7.50	3.23	4.50	64.11	59.40	11.62	14.00	9.72	3.51
8.56	7.50	3.73	4.50	64.26	59.40	10.01	14.00	10.19	3.25
8.31	7.50	3.95	4.50	63.36	59.40	11.14	14.00	9.73	3.51
7.94	6.00	3.18	4.00	62.51	51.00	10.29	17.00	11.42	4.66
7.75	6.00	3.12	4.00	60.42	51.00	16.58	17.00	7.78	4.35

CORN AND

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Valley Milling Co.—Continued.	4425	1
	4643	1
Average		5

FEED

Atchison Oatmeal and Cereal Co., Atchison, Kan.		
Kansas Ideal Horse and Mule Feed (corn, oats, oat hulls and alfalfa)	3989	1
	4153	1
	4230	1
Average		3
Corno Mills Co., East St. Louis, Ill.		
Corno Horse and Mule Feed (corn, oats, alfalfa and oat hulls)	2285	2
	2563	3
	2772	1
	2865	4
	2984	2
	3031	5
	3095	1
	3186	1
	3320	1
	3423	3
	3507	4
	3702	3
	3829	4
	3918	1
	4013	4
	4098	2
	4171	4
	4228	5
	4286	1
	4304	3
	4382	1
	4414	3
	4439	9
	4493	5
	4504	5

OAT FEEDS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
8.19	6.00	3.21	4.00	64.15	51.00	12.22	17.00	8.81	3.42
7.88	6.00	3.10	4.00	63.19	51.00	12.86	17.00	9.43	3.54
—	—	—	—	—	—	—	—	—	—
7.94	6.00	3.15	4.00	62.57	51.00	12.99	17.00	9.36	3.99

MIXTURES.

9.75	8.25	2.69	2.40	52.76	56.84	20.50	15.00	8.97	5.33
9.25	8.25	2.64	2.40	54.59	56.84	18.49	15.00	9.85	5.18
8.81	8.25	2.37	2.40	54.91	56.84	21.52	15.00	7.47	4.92
—	—	—	—	—	—	—	—	—	—
9.27	8.25	2.57	2.40	54.09	56.84	20.17	15.00	8.76	5.14

9.81	10.00	3.40	3.50	59.47	58.50	12.49	12.00	10.69	4.14
9.94	10.00	3.73	3.50	60.31	58.50	11.43	12.00	11.06	3.53
9.81	10.00	3.18	3.50	60.16	58.50	12.51	12.00	10.71	3.63
9.81	10.00	3.50	3.50	61.33	58.50	11.68	12.00	10.06	3.62
10.25	10.00	3.39	3.50	61.38	58.50	11.51	12.00	9.63	3.84
10.00	10.00	3.14	3.50	58.58	58.50	12.57	12.00	11.12	4.59
9.63	10.00	3.26	3.50	57.44	58.50	13.89	12.00	11.52	4.26
9.94	10.00	3.36	3.50	58.97	58.50	11.27	12.00	12.67	3.79
9.56	10.00	3.59	3.50	60.46	58.50	12.82	12.00	9.62	3.95
10.44	10.00	3.56	3.50	58.76	58.50	12.45	12.00	10.40	4.39
10.25	10.00	3.66	3.50	59.27	58.50	12.45	12.00	10.30	4.07
10.00	10.00	3.97	3.50	58.52	58.50	13.30	12.00	10.01	4.20
9.81	10.00	3.75	3.50	60.61	58.50	11.24	12.00	10.82	3.77
10.00	10.00	3.23	3.50	56.31	58.50	14.59	12.00	11.15	4.72
9.87	10.00	3.73	3.50	58.83	58.50	13.32	12.00	10.39	3.86
9.56	10.00	3.68	3.50	59.25	58.50	14.52	12.00	9.40	3.59
10.00	10.00	3.55	3.50	57.92	58.50	15.21	12.00	9.20	4.12
10.19	10.00	3.78	3.50	57.57	58.50	14.56	12.00	9.87	4.03
9.25	10.00	3.63	3.50	56.91	58.50	15.88	12.00	10.36	3.97
9.69	10.00	3.33	3.50	57.07	58.50	15.83	12.00	9.85	4.23
9.94	10.00	3.28	3.50	58.20	58.50	14.16	12.00	10.40	4.02
9.81	10.00	3.95	3.50	56.43	58.50	15.98	12.00	9.46	4.37
9.63	10.00	3.55	3.50	57.03	58.50	15.14	12.00	10.41	4.24
9.44	10.00	3.70	3.50	56.29	58.50	15.93	12.00	10.29	4.35
9.56	10.00	3.67	3.50	56.21	58.50	15.43	12.00	10.94	4.19

FEED

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Corno Mills Co.—Continued.		
	4596	2
	4624	8
	4700	1
	4706	2
	4795	3
	4840	1
	4859	2
	4920	3
	4943	1
	5014	2
	5097	1
	5137	1
	5176	1
	5237	5
	5282	1
	5343	2
Average		113
Creamo Dairy Feed (corn, oats, gluten feed and alfalfa)	3680	1
Cunningham Commission Co., Little Rock, Ark.		
Pulaski Corn and Oat Chops (corn, wheat bran, oats and alfalfa)	2824	1
	2971	1
	3220	1
	3421	1
	3623	1
	4799	2
	5397	1
Average		8
Good Luck Mills, St. Louis, Mo.		
Good Luck Alfalfa Feed (corn, oats, alfalfa and brewers' grains)	3536	1
	4253	1
	4444	1
	4653	1
	4807	1
	4877	1
Average		6

MIXTURES.

PROTEIN		FAT		CARBOHY-DRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
9.20	10.00	3.63	3.50	59.05	58.50	14.93	12.00	9.51	3.68
9.56	10.00	3.47	3.50	56.69	58.50	16.50	12.00	9.36	4.42
9.75	10.00	3.64	3.50	60.64	58.50	13.32	12.00	8.98	3.67
9.44	10.00	3.77	3.50	56.17	58.50	16.63	12.00	9.72	4.27
9.50	10.00	3.30	3.50	58.48	58.50	14.23	12.00	10.65	3.84
9.25	10.00	3.62	3.50	57.89	58.50	14.51	12.00	10.74	3.99
9.25	10.00	3.50	3.50	60.42	58.50	11.88	12.00	11.48	3.47
9.31	10.00	3.27	3.50	56.82	58.50	14.77	12.00	11.47	4.36
10.19	10.00	3.52	3.50	55.01	58.50	16.81	12.00	9.55	4.92
9.19	10.00	3.39	3.50	58.43	58.50	14.77	12.00	10.06	4.16
9.88	10.00	3.68	3.50	54.82	58.50	15.26	12.00	11.88	4.43
9.33	10.00	3.48	3.50	59.21	58.50	12.78	12.00	11.08	4.07
9.50	10.00	3.52	3.50	58.67	58.50	13.32	12.00	10.98	4.01
9.63	10.00	2.73	3.50	58.17	58.50	13.87	12.00	11.31	4.29
9.25	10.00	3.59	3.50	60.80	58.50	13.13	12.00	9.40	3.83
9.56	10.00	3.67	3.50	58.61	58.50	14.37	12.00	9.44	4.35
9.71	10.00	3.52	3.50	58.37	58.50	13.93	12.00	10.39	4.08
10.81	13.00	3.81	3.50	52.58	50.00	18.26	17.50	10.10	4.44
14.06	13.00	6.10	4.00	42.75	55.00	17.55	12.00	10.79	8.75
14.63	13.00	5.84	4.00	46.34	55.00	15.27	12.00	10.38	7.54
13.13	13.00	4.92	4.00	48.33	55.00	14.06	12.00	11.30	8.26
15.63	13.00	6.96	4.00	47.07	55.00	13.33	12.00	8.84	8.17
13.75	13.00	4.27	4.00	50.48	55.00	12.27	12.00	10.08	9.15
11.19	13.00	3.65	4.00	49.88	55.00	17.47	12.00	9.70	8.11
10.13	13.00	3.42	4.00	59.78	55.00	11.72	12.00	9.76	5.19
13.22	13.00	5.02	4.00	49.23	55.00	14.53	12.00	10.12	7.88
10.38	10.00	4.08	4.00	63.53	56.00	7.06	14.90	11.69	3.26
12.19	10.00	4.23	4.00	59.84	56.00	9.92	14.90	9.41	4.41
12.19	10.00	5.00	4.00	57.98	56.00	10.29	14.90	10.42	4.12
12.19	10.00	4.64	4.00	61.79	56.00	7.33	14.90	9.90	4.15
11.38	10.00	3.60	4.00	61.88	56.00	9.73	14.90	9.99	3.42
11.31	10.00	3.70	4.00	61.35	56.00	9.42	14.90	10.85	3.37
11.61	10.00	4.21	4.00	61.05	56.00	8.96	14.90	10.38	3.79

FEED

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Good Luck Mills—Continued.		
Good Luck Feed (corn, oats, alfalfa and brewers' grains)	3293	1
	3401	1
	3581	1
	4072	1
	4186	1
	4538	2
	4642	1
	4809	1
	5091	1
	5122	1
Average		11
Great Western Cereal Co., Nebraska City, Neb.		
Maizefalfa Feed (corn and alfalfa)	4874	1
Illinois Feed Mill, East St. Louis, Ill.		
Peck's Mule Feed (corn, oats, distillery product and alfalfa)	4445	1
Medlin Milling Co., Fort Worth, Tex.		
White Wolf Stock Feed (corn, rice product and alfalfa)	3675	1
	4215	1
Average		2
Quaker Oats Co., Chicago, Ill.		
Schumacher Calf Meal (contains gluten feed and oat product)	4313	1
Schumacher Stock Feed (corn, oats and barley residue)	3677	1
	3951	1
	5459	1
Average		3
Ralston Purina Co., St. Louis, Mo.		
Peerless (corn, oats, alfalfa and brewers' grains)	2213	4
	2256	2

MIXTURES.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
12.19	7.00	3.51	4.00	59.61	58.00	10.16	15.00	9.92	4.61
13.56	7.00	3.94	4.00	58.29	58.00	7.84	15.00	12.06	4.31
12.06	7.00	5.32	4.00	52.55	58.00	14.75	15.00	10.23	5.09
11.93	7.00	4.40	4.00	53.92	58.00	14.45	15.00	11.12	4.18
12.69	7.00	4.88	4.00	53.70	58.00	13.17	15.00	9.45	6.11
12.25	7.00	3.97	4.00	57.29	58.00	13.22	15.00	8.95	4.32
12.25	7.00	4.46	4.00	54.73	58.00	12.48	15.00	11.43	4.65
12.00	7.00	3.98	4.00	56.85	58.00	14.04	15.00	8.87	4.26
13.06	7.00	4.37	4.00	53.07	58.00	14.47	15.00	10.37	4.66
11.88	7.00	4.35	4.00	55.38	58.00	13.80	15.00	9.96	4.63
12.39	7.00	4.32	4.00	55.53	58.00	12.84	15.00	10.24	4.68
11.75	12.00	4.02	4.00	55.47	58.00	11.76	11.00	11.08	5.92
12.13	7.20	3.91	3.80	55.54	58.80	13.63	15.10	9.88	4.91
13.29	13.61	2.36	4.01	50.33	60.09	15.93	7.97	12.82	5.27
12.31	13.61	2.63	4.01	52.94	60.09	16.62	7.97	9.32	6.18
12.80	13.61	2.50	4.01	51.63	60.09	16.27	7.97	11.07	5.73
20.47	19.00	7.72	8.00	59.82	54.00	2.87	3.00	6.40	2.72
11.31	10.00	3.71	4.00	62.20	60.00	9.18	10.00	10.24	3.36
10.87	10.00	3.59	4.00	61.50	60.00	10.64	10.00	9.89	3.51
10.75	10.00	3.39	4.00	62.66	60.00	10.61	10.00	8.44	4.15
10.98	10.00	3.56	4.00	62.12	60.00	10.15	10.00	9.52	3.67
13.88	7.40	4.66	3.80	59.49	59.20	7.84	14.70	10.62	3.51
15.25	7.40	5.29	3.80	57.87	59.20	7.88	14.70	10.35	3.36

FEED

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Ralston Purina Co.—Continued.		
	2408	1
	2576	3
	3050	1
	3121	1
	3422	2
	3570	3
	3689	1
	3832	1
	4071	1
	4110	2
	4158	8
	4422	1
Average		25
Peerless (corn, oats, alfalfa and brewers' grains)	4521	1
	4611	3
	4663	1
	4730	1
	4796	2
	5053	1
	5253	1
	5409	1
Average		11
Protena Alfalfa Feed (corn, oats, alfalfa and brewers' grains)	2768	1
	2884	2
	3500	1
	3643	1
	4021	3
Average		8
Protena Alfalfa Feed (corn, oats, alfalfa and brewers' grains)	4469	1
	4636	1
	4815	1
Average		3
Protena Dairy Feed (alfalfa, corn, wheat products and cotton seed meal)	3676	1
	3864	1
Average		2

MIXTURES.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
15.94	7.40	5.81	3.80	55.77	59.20	8.90	14.70	9.93	3.65
12.58	7.40	3.34	3.80	60.04	59.20	7.99	14.70	12.37	3.68
13.44	7.40	3.92	3.80	56.50	59.20	9.30	14.70	11.97	4.87
12.19	7.40	3.26	3.80	57.30	59.20	9.73	14.70	13.52	4.00
11.06	7.40	3.67	3.80	60.97	59.20	9.23	14.70	11.28	3.79
12.13	7.40	4.42	3.80	56.51	59.20	12.21	14.70	10.91	3.82
12.75	7.40	4.00	3.80	59.15	59.20	9.10	14.70	10.76	4.24
12.75	7.40	4.79	3.80	55.86	59.20	12.18	14.70	10.50	3.92
11.62	7.40	3.81	3.80	55.39	59.20	13.25	14.70	11.35	4.58
12.50	7.40	4.51	3.80	53.47	59.20	14.41	14.70	10.27	4.84
12.06	7.40	3.97	3.80	56.68	59.20	13.85	14.70	8.93	4.51
12.94	7.40	4.34	3.80	54.35	59.20	14.06	14.70	9.18	5.13
—	—	—	—	—	—	—	—	—	—
12.94	7.40	4.27	3.80	57.10	59.20	10.71	14.70	10.85	4.13
11.94	9.00	3.87	3.50	58.16	57.00	12.89	12.00	8.95	4.19
12.44	9.00	4.48	3.50	56.31	57.00	11.98	12.00	10.56	4.23
12.56	9.00	4.27	3.50	56.26	57.00	13.91	12.00	8.72	4.28
13.13	9.00	4.01	3.50	56.20	57.00	13.28	12.00	8.92	4.46
12.31	9.00	4.48	3.50	55.82	57.00	13.08	12.00	10.38	3.93
12.56	9.00	4.98	3.50	53.70	57.00	13.21	12.00	11.42	4.13
12.69	9.00	4.03	3.50	53.10	57.00	14.81	12.00	11.02	4.35
12.25	9.00	4.55	3.50	53.66	57.00	14.05	12.00	11.22	4.27
—	—	—	—	—	—	—	—	—	—
12.49	9.00	4.33	3.50	55.40	57.00	13.40	12.00	10.15	4.23
13.69	12.30	2.97	4.00	58.04	56.00	9.74	11.90	11.65	3.91
13.06	12.30	3.73	4.00	59.45	56.00	9.75	11.90	10.08	3.93
11.19	12.30	3.51	4.00	60.54	56.00	8.75	11.90	12.39	3.62
12.69	12.30	4.76	4.00	51.29	56.00	14.31	11.90	11.42	5.53
11.81	12.30	4.55	4.00	58.22	56.00	10.16	11.90	10.82	4.44
—	—	—	—	—	—	—	—	—	—
12.49	12.30	3.90	4.00	57.51	56.00	10.54	11.90	11.27	4.29
11.81	12.00	3.92	3.80	59.60	57.00	9.51	9.70	11.32	3.84
11.69	12.00	4.03	3.80	59.24	57.00	9.59	9.70	11.05	4.40
12.19	12.00	3.51	3.80	63.95	57.00	8.42	9.70	8.69	3.24
—	—	—	—	—	—	—	—	—	—
11.90	12.00	3.82	3.80	60.93	57.00	9.17	9.70	10.35	3.83
20.63	20.00	5.84	3.50	42.06	48.00	13.91	16.00	11.79	5.77
21.75	20.00	6.11	3.50	41.58	48.00	16.25	16.00	9.23	5.08
—	—	—	—	—	—	—	—	—	—
21.19	20.00	5.98	3.50	41.82	48.00	15.08	16.00	10.51	5.42

FEED

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Ralston Purina Co., St. Louis, Mo.		
Purina Feed (alfalfa, corn, oats and brewer's grains)....	2283	3
	2389	5
	2513	5
	2666	1
	2785	3
	2889	2
	3034	2
	3116	2
	3155	2
	3251	3
	3365	1
	3511	3
	3553	14
	3649	3
	3737	3
	3813	1
	3822	6
	3885	2
	3960	2
	4084	3
	4100	2
	4174	10
	4226	4
Average		82
Purina Feed (alfalfa, corn, oats and brewer's grains)....	4432	4
	4496	2
	4528	2
	4577	1
	4584	7
	4654	1
	4687	1
	4701	2
	4759	4
	4782	1
	4788	7
	4876	1
	4916	2
	4963	2
	5070	1
	5075	2
	5109	5
	5187	3
	5258	1
	5349	2
Average		51

MIXTURES.

PROTEIN		FAT		CARBOHY-DRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
14.50	14.00	5.15	6.00	60.23	60.00	6.41	7.90	10.95	2.76
14.19	14.00	4.61	6.00	60.45	60.00	6.50	7.90	11.35	2.90
13.95	14.00	4.04	6.00	56.79	60.00	10.22	7.90	10.24	4.76
11.88	14.00	3.32	6.00	61.63	60.00	8.40	7.90	11.69	3.08
13.56	14.00	3.93	6.00	58.81	60.00	8.54	7.90	11.20	3.96
13.31	14.00	4.06	6.00	60.47	60.00	8.65	7.90	9.96	3.55
13.63	14.00	4.18	6.00	58.52	60.00	8.95	7.90	10.15	4.57
13.25	14.00	3.97	6.00	56.70	60.00	8.78	7.90	13.27	4.03
13.75	14.00	4.40	6.00	57.73	60.00	8.79	7.90	11.12	4.21
13.63	14.00	3.94	6.00	57.92	60.00	8.62	7.90	12.04	3.85
13.06	14.00	4.57	6.00	62.04	60.00	8.20	7.90	8.55	3.58
12.25	14.00	4.20	6.00	59.25	60.00	9.42	7.90	10.85	4.03
13.20	14.00	4.27	6.00	57.74	60.00	9.15	7.90	11.68	3.96
14.06	14.00	4.38	6.00	55.83	60.00	9.36	7.90	11.88	4.49
12.88	14.00	4.15	6.00	58.26	60.00	9.52	7.90	10.97	4.22
12.94	14.00	4.02	6.00	57.87	60.00	8.62	7.90	12.71	3.84
12.25	14.00	4.11	6.00	58.99	60.00	9.15	7.90	11.79	3.71
12.13	14.00	4.01	6.00	61.64	60.00	7.50	7.90	10.29	4.43
13.75	14.00	3.91	6.00	56.85	60.00	9.92	7.90	11.14	4.43
12.43	14.00	4.20	6.00	59.28	60.00	8.99	7.90	10.67	4.43
11.63	14.00	3.71	6.00	60.79	60.00	8.24	7.90	10.06	5.57
12.50	14.00	3.98	6.00	59.42	60.00	9.45	7.90	9.95	4.70
12.56	14.00	4.29	6.00	58.52	60.00	9.44	7.90	10.91	4.28
13.10	14.00	4.15	6.00	58.94	60.00	8.73	7.90	11.02	4.06
12.69	12.50	3.90	4.00	64.86	58.90	4.27	8.90	10.37	3.91
12.38	12.50	3.92	4.00	60.02	58.90	8.74	8.90	10.51	4.48
11.69	12.50	3.80	4.00	57.13	58.90	12.11	8.90	11.32	3.95
12.44	12.50	4.16	4.00	60.27	58.90	10.27	8.90	9.29	3.57
12.50	12.50	4.32	4.00	58.97	58.90	10.02	8.90	10.37	3.82
13.19	12.50	3.32	4.00	59.23	58.90	9.42	8.90	9.97	4.87
13.75	12.50	3.85	4.00	58.43	58.90	10.71	8.90	8.93	4.38
12.88	12.50	3.70	4.00	57.76	58.90	10.28	8.90	11.14	4.24
13.81	12.50	4.16	4.00	56.83	58.90	10.71	8.90	10.72	3.77
12.25	12.50	3.71	4.00	60.13	58.90	9.98	8.90	9.93	4.00
13.13	12.50	4.12	4.00	58.28	58.90	10.36	8.90	9.63	4.48
13.44	12.50	4.34	4.00	56.07	58.90	10.88	8.90	10.41	4.86
12.13	12.50	3.96	4.00	58.87	58.90	8.24	8.90	11.06	5.74
13.38	12.50	4.30	4.00	57.07	58.90	10.18	8.90	10.92	4.15
13.19	12.50	4.08	4.00	58.51	58.90	9.20	8.90	10.64	4.38
13.00	12.50	4.49	4.00	55.17	58.90	10.78	8.90	11.39	5.17
12.69	12.50	3.88	4.00	56.78	58.90	10.12	8.90	11.87	4.66
13.06	12.50	3.94	4.00	55.56	58.90	10.56	8.90	11.87	5.01
13.63	12.50	4.86	4.00	57.42	58.90	10.80	8.90	8.67	4.62
12.69	12.50	5.41	4.00	59.61	58.90	9.07	8.90	9.37	3.85
12.90	12.50	4.11	4.00	58.35	58.90	9.83	8.90	10.42	4.39

FEED

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Shawnee Milling Co., Shawnee, Okla.		
Profalfa Dairy and Stock Feed (corn and alfalfa)	4780	1
	5362	1
Average		2
Jno. Wade and Son, Memphis, Tenn.		
Purity Feed	2456	1
	3600	1
	3808	1
	5308	1
Average		4
Webb and Maury, Memphis, Tenn.		
Memphis Stock Feed (corn, oats, wheat bran, brewer's grains and alfalfa)	5217	10
Otto Weiss Alfalfa Stock Feed Co., Wichita, Kans.		
Otto Weiss Alfalfa Stock Feed No. 2 (corn, wheat bran, linseed meal and alfalfa)	3150	1
	3624	1
	3809	1
	4007	1
	4314	1
	4772	1
	5035	2
	5159	1
Average		9

HOMINY

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
American Hominy Co., Mt. Vernon, Ind.		
Homco Feed	2247	2
	2769	1
	3585	1
	3858	1
	3950	1
	4272	1

MIXTURES.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
13.44	12.25	3.06	2.97	54.31	53.20	13.63	16.58	10.05	5.51
11.94	12.25	2.48	2.97	51.18	53.20	17.67	16.58	8.35	8.38
12.69	12.25	2.77	2.97	52.74	53.20	15.65	16.58	9.20	6.95
12.63	9.09	4.82	4.15	63.95	60.56	5.83	8.89	9.98	2.79
9.50	9.09	3.79	4.15	68.11	60.56	5.89	8.89	10.54	2.17
8.75	9.09	3.39	4.15	67.67	60.56	6.27	8.89	11.76	2.16
9.06	9.09	3.83	4.15	68.16	60.56	5.80	8.89	10.85	2.30
9.99	9.09	3.96	4.15	66.97	60.56	5.95	8.89	10.78	2.35
16.19	12.95	4.25	3.31	52.54	55.49	11.55	11.67	10.70	4.77
11.13	12.05	3.31	3.73	59.86	53.59	7.48	17.00	14.04	4.18
13.06	12.05	3.72	3.73	56.91	53.59	10.03	17.00	10.64	5.64
12.63	12.05	3.60	3.73	57.51	53.59	9.79	17.00	11.31	5.16
11.50	12.05	3.34	3.73	61.02	53.59	9.53	17.00	9.59	5.02
11.69	12.05	3.14	3.73	60.47	53.59	9.13	17.00	10.39	5.18
11.75	12.05	3.00	3.73	59.65	53.59	10.80	17.00	10.64	4.16
12.44	12.05	3.25	3.73	58.90	53.59	9.94	17.00	10.03	5.44
12.00	12.05	3.27	3.73	53.16	53.59	15.03	17.00	10.97	5.57
12.03	12.05	3.33	3.73	58.43	53.59	10.22	17.00	10.95	5.04

FEEDS.

13.38	9.52	8.31	9.42	62.61	67.89	3.64	3.28	9.47	2.59
11.58	9.52	9.11	9.42	64.49	67.89	3.31	3.28	8.46	3.07
10.31	9.52	8.35	9.42	66.06	67.89	3.37	3.28	9.31	2.60
10.13	9.52	8.68	9.42	66.14	67.89	3.67	3.28	8.79	2.59
10.50	9.52	8.42	9.42	66.06	67.89	3.09	3.28	9.11	2.82
10.25	9.52	7.97	9.42	67.44	67.89	3.54	3.28	8.18	2.62

HOMINY

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
American Hominy Co.—Continued.	4533	2
	4935	1
Average		10
Hominy Feed	5458	1
Charles Broeker and Co., Owensboro, Ky.		
Hominy Feed	3669	3
	3850	1
Average		4
T. H. Bunch and Co., Little Rock, Ark.		
Hominy Feed	2210	10
	2273	2
	2496	1
	2888	3
	3157	1
	3679	1
	4005	1
	4569	2
	4604	1
	4933	1
	5032	3
	5163	1
	5204	1
	5266	4
	5351	2
Average		34
Cumberland and Liberty Mills, Nashville, Tenn.		
Hominy Feed	3302	1
	3391	4
	5047	1
Average		6

FEEDS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
10.13	9.52	8.69	9.42	67.18	67.89	3.32	3.28	7.91	2.77
10.94	9.52	8.15	9.42	68.02	67.89	3.05	3.28	7.11	2.73
10.90	9.52	8.46	9.42	66.01	67.89	3.37	3.28	8.54	2.72
11.38	8.34	8.15	7.75	68.38	65.78	2.65	4.25	6.54	2.90
10.31	8.00	8.34	3.00	63.49	50.00	5.24	5.00	9.77	2.85
10.56	8.00	9.50	3.00	62.78	50.00	4.97	5.00	9.24	2.95
10.43	8.00	8.92	3.00	63.13	50.00	5.10	5.00	9.52	2.90
9.56	8.70	7.40	7.25	64.22	65.75	7.18	8.08	9.39	2.25
10.13	8.70	7.71	7.25	62.77	65.75	6.47	8.08	10.58	2.34
9.00	8.70	6.80	7.25	63.90	65.75	9.40	8.08	8.76	2.14
9.13	8.70	7.03	7.25	65.50	65.75	7.95	8.08	8.16	2.23
8.06	8.70	6.64	7.25	64.79	65.75	9.36	8.08	9.04	2.11
7.81	8.70	6.49	7.25	63.36	65.75	11.39	8.08	8.85	2.08
8.06	8.70	6.13	7.55	63.23	65.75	11.60	8.08	8.84	2.14
9.13	8.70	7.11	7.25	62.94	65.75	9.47	8.08	8.99	2.36
9.19	8.70	6.88	7.25	63.96	65.75	8.49	8.08	9.08	2.40
9.88	8.70	7.18	7.25	64.23	65.75	8.91	8.08	7.40	2.40
9.50	8.70	6.89	7.25	64.07	65.75	8.84	8.08	8.28	2.42
9.38	8.70	6.86	7.25	64.30	65.75	7.38	8.08	9.08	3.00
9.63	8.70	7.37	7.25	62.24	65.75	8.14	8.08	9.78	2.84
8.88	8.70	6.64	7.25	65.18	65.75	8.44	8.08	8.02	2.84
8.88	8.70	6.61	7.25	64.19	65.75	8.60	8.08	9.30	2.43
9.08	8.70	6.92	7.25	63.93	65.75	8.78	8.08	8.90	2.39
11.63	10.50	8.84	10.00	61.26	50.00	4.81	6.81	10.68	2.78
10.31	10.50	7.97	10.00	64.71	50.00	4.97	6.81	9.42	2.62
10.19	10.50	8.57	10.00	63.85	50.00	6.24	6.81	7.99	3.16
10.71	10.50	8.46	10.00	63.28	50.00	5.34	6.81	9.36	2.85

FEED

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Blodgett Elevator and Grain Co., Blodgett, Mo.		
Feed Meal	2743	1
Dahnke-Walker Milling Co., Union City, Tenn.		
Corn Feed Meal	3935	2
	4424	1
Average		3
Davis and Andrews Co., Memphis, Tenn.		
Feed Meal	5007	2
	5063	1
Average		3
B. F. Glover and Son Commission Co., New Orleans, La.		
New Basin Cow Feed	2196	11
	2346	2
	2450	4
	2607	3
	2710	2
	2842	1
	2932	1
	2997	1
	3120	2
	3364	2
	3538	2
	3712	1
	3804	1
	3859	1
	4004	1
	4102	2
	4178	1
	4266	1
	4389	1
	4605	1

MEALS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
11.00	14.00	4.81	4.50	71.50	65.00	3.82	4.50	6.35	2.52
7.37	6.70	4.58	4.50	64.92	59.00	11.76	12.00	9.46	1.91
8.19	6.70	4.63	4.50	65.79	59.00	8.49	12.00	11.01	1.89
—	—	—	—	—	—	—	—	—	—
7.78	6.70	4.61	4.50	65.35	59.00	10.13	12.00	10.23	1.90
8.50	11.97	6.31	8.49	65.03	61.31	9.54	6.25	8.20	2.42
9.06	11.97	2.43	8.49	70.30	61.31	9.29	6.25	6.49	2.43
—	—	—	—	—	—	—	—	—	—
8.78	11.97	4.37	8.49	67.66	61.31	9.42	6.25	7.34	2.43
9.93	10.10	5.14	6.90	68.03	64.26	3.50	6.60	11.14	2.26
9.87	10.10	6.72	6.90	66.11	64.26	4.38	6.60	10.63	2.29
10.19	10.10	6.63	6.90	66.22	64.26	5.06	6.60	9.62	2.28
11.19	10.10	6.15	6.90	67.29	64.26	3.67	6.60	9.57	2.13
9.19	10.10	3.57	6.90	72.52	64.26	1.58	6.60	11.66	1.48
8.90	10.10	3.23	6.90	71.60	64.26	1.35	6.60	13.55	1.37
8.94	10.10	5.64	6.90	67.56	64.26	6.13	6.60	9.60	2.13
8.06	10.10	5.14	6.90	65.81	64.26	8.36	6.60	10.60	2.03
8.69	10.10	5.03	6.90	66.98	64.26	5.70	6.60	11.67	1.93
8.94	10.10	5.51	6.90	68.04	64.26	5.14	6.60	10.12	2.25
9.13	10.10	5.06	6.90	69.96	64.26	3.10	6.60	10.64	2.11
9.63	10.10	6.16	6.90	67.70	64.26	3.64	6.60	10.42	2.45
8.81	10.10	4.60	6.90	69.87	64.26	3.19	6.60	11.36	2.17
9.25	10.10	5.60	6.90	69.30	64.26	3.47	6.60	10.21	2.17
7.81	10.10	2.83	6.90	73.04	64.26	1.86	6.60	12.48	1.98
9.56	10.10	5.48	6.90	70.86	64.26	2.45	6.60	9.51	2.14
9.31	10.10	5.60	6.90	70.31	64.26	2.47	6.60	10.19	2.12
9.38	10.10	4.83	6.90	72.76	64.26	2.27	6.60	8.74	2.02
9.19	10.10	5.84	6.90	70.39	64.26	2.72	6.60	9.44	2.42
9.75	10.10	5.86	6.90	67.92	64.26	4.87	6.60	9.43	2.17

FEED

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
B. F. Glover and Son Commission Co.—Continued.		
	4634	1
	4743	1
	4802	2
	4908	1
	3210	1
	4969	2
	5085	1
	5152	1
	5298	1
	5470	1
Average		53
Yates and Donelson Co., Memphis, Tenn.		
Feed Meal	2540	2
	2987	1
	3274	2
	3678	1
	4557	1
	5051	1
Average		8

BREWERS'

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Anheuser Busch Brewing Association, St. Louis, Mo.		
Dried Brewers' Grains	4502	1
	4740	1
	5087	1
Average		3
Houston Ice and Brewing Co., Houston, Tex.		
Dried Brewers' Grains	4453	4
	4539	1
Average		5

MEALS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
8.38	10.10	4.24	6.90	69.89	64.26	6.03	6.60	9.55	1.91
9.13	10.10	5.92	6.90	67.41	64.26	6.57	6.60	8.66	2.31
9.19	10.10	5.59	6.90	69.40	64.26	5.76	6.60	7.96	2.10
8.31	10.10	5.24	6.90	67.58	64.26	6.76	6.60	10.06	2.05
9.13	10.10	6.32	6.90	65.13	64.26	7.10	6.60	10.03	2.29
8.38	10.10	3.62	6.90	72.05	64.26	4.41	6.60	9.42	2.12
8.56	10.10	5.25	6.90	66.17	64.26	6.87	6.60	10.79	2.36
10.38	10.10	2.69	6.90	71.57	64.26	1.74	6.60	11.17	2.45
7.94	10.10	3.72	6.90	72.68	64.26	3.74	6.60	9.57	2.35
10.13	10.10	4.11	6.90	70.75	64.26	2.82	6.60	9.93	2.26
9.18	10.10	5.04	6.90	69.16	64.26	4.22	6.60	10.26	2.14
10.56	10.10	5.75	6.90	69,17	64.25	3.37	6.60	9.35	1.80
11.63	10.10	8.46	6.90	60.97	64.25	6.48	6.60	9.74	2.72
11.06	10.10	7.94	6.90	61.89	64.25	6.70	6.60	9.74	2.67
9.44	10.10	5.06	6.90	69.57	64.25	4.15	6.60	9.79	1.99
11.06	10.10	7.16	6.90	64.75	64.25	5.73	6.60	8.72	2.58
10.19	10.10	6.45	6.90	65.55	64.25	6.87	6.60	8.58	2.36
10.66	10.10	6.80	6.90	65.32	64.25	5.55	6.60	9.32	2.35

GRAINS.

23.31	24.00	6.47	7.50	42.53	45.00	16.24	12.00	7.87	3.58
28.00	24.00	6.90	7.50	39.03	45.00	13.40	12.00	9.27	3.40
25.88	24.00	6.67	7.50	41.21	45.00	13.58	12.00	8.82	3.84
25.73	24.00	6.69	7.50	40.92	45.00	14.41	12.00	8.65	3.60
24.69	21.25	5.98	5.46	43.11	47.94	13.94	17.25	8.93	3.35
27.31	21.25	5.77	5.46	40.98	47.94	14.03	17.25	8.26	3.65
26.00	21.25	5.88	5.46	42.05	47.94	13.98	17.25	8.59	3.50

BREWERS'

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
K. and E. Neumond, New Orleans, La.		
Dried Brewers' Grains	2198	7
	2505	3
	2616	1
	2694	2
	2741	1
	2835	1
	2942	1
	3094	1
	3184	2
	3321	1
	3408	1
	3491	1
	3653	1
	3755	2
	3877	2
	4012	2
	4130	2
	4324	2
	4412	3
	4537	2
	4625	2
	4708	3
	4836	2
	4923	2
	4977	1
	5094	1
	5124	1
	5219	1
	5283	1
	5473	1
Average		53
New Orleans Brewing Co., New Orleans, La.		
New Orleans Brewing Co.'s Brewers' Grains	3066	2
	3200	1
	3258	1
	3370	1
	3460	1
	3549	1
	3713	1
	3948	1
	4113	2
	4269	1

GRAINS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
26.25	23.81	6.76	5.02	40.24	37.63	13.00	16.77	10.16	3.59
25.50	23.81	6.57	5.02	39.62	37.63	13.74	16.77	11.24	3.30
25.31	23.81	5.97	5.02	38.88	37.63	12.59	16.77	13.75	3.50
23.44	23.81	6.47	5.02	42.59	37.63	14.95	16.77	9.02	3.53
29.75	23.81	6.79	5.02	36.98	37.63	12.34	16.77	10.89	3.25
26.13	23.81	6.43	5.02	36.93	37.63	13.98	16.77	13.20	3.33
30.56	23.81	7.30	5.02	37.36	37.63	12.53	16.77	8.76	3.49
28.13	23.81	6.93	5.02	37.44	37.63	14.40	16.77	8.96	4.14
24.97	23.81	6.70	5.02	40.04	37.63	14.53	16.77	10.13	3.62
30.38	23.81	7.40	5.02	35.25	37.63	13.61	16.77	9.38	3.98
28.38	23.81	7.35	5.02	36.16	37.63	13.70	16.77	10.84	3.57
28.88	23.81	7.17	5.02	35.54	37.63	13.31	16.77	11.25	3.85
28.63	23.81	7.26	5.02	36.09	37.63	14.07	16.77	10.40	3.55
25.25	23.81	6.31	5.02	40.21	37.63	14.50	16.77	9.94	3.79
27.31	23.81	6.39	5.02	38.97	37.63	14.78	16.77	9.11	3.44
28.69	23.81	6.91	5.02	37.86	37.63	13.86	16.77	9.05	3.63
23.87	23.81	6.24	5.02	41.00	37.63	15.20	16.77	10.34	3.25
26.00	23.81	6.54	5.02	40.60	37.63	13.17	16.77	10.22	3.47
27.81	23.81	6.76	5.02	40.15	37.63	13.13	16.77	8.85	3.30
25.75	23.81	6.80	5.02	41.89	37.63	14.12	16.77	7.83	3.61
22.31	23.81	6.08	5.02	42.62	37.63	16.88	16.77	8.38	3.73
23.19	23.81	6.13	5.02	41.46	37.63	15.67	16.77	10.12	3.43
26.56	23.81	6.83	5.02	39.06	37.63	14.42	16.77	9.62	3.51
26.69	23.81	6.56	5.02	38.20	37.63	14.06	16.77	10.77	3.72
30.38	23.81	6.88	5.02	37.63	37.63	12.31	16.77	9.37	3.43
27.56	23.81	6.05	5.02	38.74	37.63	12.86	16.77	11.30	3.49
25.88	23.81	7.40	5.02	44.08	37.63	11.20	16.77	6.89	4.55
25.75	23.81	6.73	5.02	43.09	37.63	12.84	16.77	7.89	3.70
27.75	23.81	6.85	5.02	40.22	37.63	13.00	16.77	8.61	3.57
25.13	23.81	6.16	5.02	38.43	37.63	15.54	16.77	11.10	3.64
26.74	23.81	6.69	5.02	39.25	37.63	13.81	16.77	9.91	3.60
24.14	25.00	6.93	5.00	40.14	35.00	16.27	12.00	7.86	4.66
26.88	25.00	6.48	5.00	39.75	35.00	14.49	12.00	8.99	3.41
29.81	25.00	7.67	5.00	39.69	35.00	15.05	12.00	4.31	3.47
30.50	25.00	7.52	5.00	40.11	35.00	13.08	12.00	5.54	3.25
29.69	25.00	7.29	5.00	37.49	35.00	13.58	12.00	8.59	3.36
26.25	25.00	6.89	5.00	41.20	35.00	15.04	12.00	7.04	3.58
23.31	25.00	7.23	5.00	40.83	35.00	16.74	12.00	8.61	3.28
29.50	25.00	6.72	5.00	39.12	35.00	12.66	12.00	8.63	3.37
27.19	25.00	6.76	5.00	39.53	35.00	15.37	12.00	7.73	3.42
28.94	25.00	6.57	5.00	41.15	35.00	14.57	12.00	5.26	3.51

BREWERS'

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
New Orleans Brewing Co.—Continued.		
	4347	2
	4451	2
	4721	2
	4793	3
	4870	1
	5066	1
	5156	1
	5299	1
	5364	1
Average		26

POULTRY

W. F. Chamberlain, St. Louis, Mo.		
Chamberlain's Chick Feed	2300	1
	2702	1
	3206	1
	3498	1
	3729	2
	4164	2
	4599	1
	5002	1
Average		10
Chamberlain's Hen Feed	2297	1
	2549	1
	2899	1
	3497	1
	3751	1
	4201	1
	5001	1
	5111	4
	5203	1
	5261	1
Average		13
Chamberlain's Pigeon Feed	2296	1
	2546	1
	3499	1
	4962	2
Average		5

GRAINS.

PROTEIN		FAT		CARBOHY-DRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
22.25	25.00	5.76	5.00	41.67	35.00	16.46	12.00	9.77	4.09
24.25	25.00	5.86	5.00	41.18	35.00	16.50	12.00	8.72	3.49
24.25	25.00	6.11	5.00	42.38	35.00	15.02	12.00	9.17	3.07
24.94	25.00	6.34	5.00	42.62	35.00	14.96	12.00	7.77	3.37
27.31	25.00	6.31	5.00	42.35	35.00	14.47	12.00	6.40	3.16
20.94	25.00	5.59	5.00	43.39	35.00	16.90	12.00	9.59	3.59
25.88	25.00	5.83	5.00	40.70	35.00	15.49	12.00	8.51	3.59
22.38	25.00	5.95	5.00	44.71	35.00	17.22	12.00	6.26	3.48
21.19	25.00	6.36	5.00	44.66	35.00	17.72	12.00	6.40	3.67
———	———	———	———	———	———	———	———	———	———
25.77	25.00	6.54	5.00	41.19	35.00	15.35	12.00	7.64	3.51

FEEDS.

12.25	12.00	2.31	3.00	55.19	30.00	3.74	8.00	9.79	16.72
12.25	12.00	2.57	3.00	56.06	30.00	3.84	8.00	9.22	16.06
8.69	12.00	3.23	3.00	59.22	30.00	2.21	8.00	10.84	15.81
11.69	12.00	2.95	3.00	49.89	30.00	4.06	8.00	8.68	22.73
11.81	12.00	3.05	3.00	58.99	30.00	2.96	8.00	9.22	13.97
12.00	12.00	2.72	3.00	53.99	30.00	3.49	8.00	8.00	19.80
12.00	12.00	2.49	3.00	60.46	30.00	4.15	8.00	8.81	12.09
11.56	12.00	2.55	3.00	58.18	30.00	3.64	8.00	9.45	14.62
———	———	———	———	———	———	———	———	———	———
11.53	12.00	2.73	3.00	56.50	30.00	3.51	8.00	9.25	16.48
11.46	11.00	3.82	5.00	56.44	30.00	4.89	9.00	10.04	13.35
10.51	11.00	3.44	5.00	58.05	30.00	3.93	9.00	10.18	13.89
9.25	11.00	3.24	5.00	61.70	30.00	2.63	9.00	12.99	10.19
8.44	11.00	3.16	5.00	60.42	30.00	3.05	9.00	11.21	13.72
8.63	11.00	2.96	5.00	63.65	30.00	2.24	9.00	12.35	10.17
9.31	11.00	2.82	5.00	63.59	30.00	3.02	9.00	11.31	9.95
10.38	11.00	3.10	5.00	64.90	30.00	2.81	9.00	10.60	8.21
9.50	11.00	2.58	5.00	60.34	30.00	4.95	9.00	9.32	13.31
9.38	11.00	2.40	5.00	59.67	30.00	3.56	9.00	9.88	15.11
10.62	11.00	2.59	5.00	63.11	30.00	3.56	9.00	8.78	11.34
———	———	———	———	———	———	———	———	———	———
9.75	11.00	3.01	5.00	61.19	30.00	3.46	9.00	10.67	11.92
11.69	12.00	3.26	5.00	65.57	30.00	3.34	8.00	10.15	5.99
11.19	12.00	3.48	5.00	60.46	30.00	3.15	8.00	9.98	11.74
9.81	12.00	3.75	5.00	67.56	30.00	3.24	8.00	12.37	3.27
9.94	12.00	3.27	5.00	67.88	30.00	2.58	8.00	11.27	5.06
———	———	———	———	———	———	———	———	———	———
10.66	12.00	3.44	5.00	65.36	30.00	3.08	8.00	10.94	6.52

POULTRY

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Corno Mills Co., East St. Louis, Ill.		
Corno Chick Feed	2228	3
	2538	2
	2778	1
	3496	1
	3749	1
	3806	1
	3916	1
	4041	1
	4144	1
	4270	1
	4333	1
	4384	1
	4416	1
	4437	5
	4585	4
	4626	2
	4727	1
	4852	2
	4514	4
	4887	1
	5149	1
Average		36
Corno Hen Feed	2200	7
	2270	2
	2534	5
	2633	2
	2776	1
	3519	2
	3659	3
	3874	2
	4040	1
	4267	1
	4334	1
	4354	3
	4420	1
	4426	3
	4517	5
	4586	3
	4617	4
	4846	1
	4855	3
	4886	1
	2386	2

FEEDS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
10.69	10.00	2.85	3.50	70.64	70.00	2.72	3.40	11.29	1.81
10.94	10.00	2.76	3.50	69.83	70.00	3.01	3.40	11.62	1.84
10.55	10.00	2.72	3.50	70.50	70.00	2.72	3.40	11.69	1.82
10.81	10.00	2.57	3.50	69.67	70.00	2.73	3.40	12.01	2.21
10.81	10.00	2.83	3.50	68.45	70.00	2.59	3.40	13.59	1.73
10.88	10.00	2.70	3.50	69.69	70.00	2.24	3.40	12.54	1.95
11.13	10.00	2.60	3.50	70.42	70.00	2.44	3.40	11.58	1.83
11.25	10.00	2.74	3.50	69.67	70.00	2.45	3.40	11.87	2.02
11.06	10.00	2.89	3.50	69.77	70.00	2.71	3.40	11.74	1.83
10.00	10.00	2.40	3.50	72.79	70.00	3.41	3.40	9.25	2.15
11.88	10.00	2.88	3.50	68.25	70.00	2.82	3.40	10.13	2.04
11.19	10.00	3.06	3.50	70.60	70.00	2.92	3.40	10.29	1.94
10.56	10.00	2.89	3.50	71.12	70.00	2.75	3.40	10.85	1.83
11.13	10.00	3.04	3.50	70.72	70.00	2.58	3.40	10.75	1.78
10.81	10.00	2.56	3.50	71.11	70.00	2.55	3.40	11.27	1.70
10.62	10.00	2.31	3.50	71.04	70.00	2.69	3.40	11.54	1.80
10.13	10.00	2.59	3.50	72.76	70.00	2.86	3.40	9.80	1.86
10.25	10.00	2.51	3.50	71.93	70.00	2.43	3.40	11.15	1.73
11.00	10.00	2.67	3.50	71.33	70.00	2.64	3.40	10.74	1.62
10.19	10.00	2.53	3.50	69.23	70.00	2.87	3.40	13.12	2.06
9.81	10.00	2.62	3.50	71.60	70.00	2.57	3.40	11.60	1.80
10.75	10.00	2.61	3.50	70.53	70.00	2.70	3.40	11.35	1.86
10.50	10.00	3.09	3.70	71.23	70.00	2.41	2.30	11.33	1.44
10.44	10.00	3.32	3.70	70.06	70.00	2.56	2.30	12.18	1.44
10.69	10.00	3.29	3.70	71.25	70.00	2.32	2.30	11.03	1.42
10.31	10.00	3.18	3.70	70.90	70.00	2.52	2.30	11.67	1.42
10.09	10.00	2.76	3.70	70.68	70.00	2.41	2.30	12.67	1.39
10.50	10.00	2.88	3.70	71.23	70.00	2.16	2.30	11.73	1.50
10.25	10.00	3.11	3.70	70.54	70.00	2.64	2.30	12.02	1.44
10.06	10.00	4.13	3.70	70.58	70.00	3.20	2.30	10.62	1.41
10.13	10.00	3.30	3.70	70.49	70.00	2.40	2.30	12.29	1.39
9.87	10.00	3.33	3.70	72.67	70.00	2.62	2.30	10.03	1.48
10.38	10.00	3.51	3.70	72.16	70.00	2.45	2.30	10.09	1.41
10.06	10.00	3.58	3.70	70.80	70.00	2.51	2.30	11.60	1.45
10.44	10.00	3.39	3.70	71.80	70.00	2.22	2.30	10.69	1.46
10.75	10.00	2.83	3.70	72.39	70.00	1.99	2.30	10.52	1.52
10.13	10.00	3.45	3.70	72.01	70.00	2.79	2.30	10.14	1.48
10.44	10.00	4.01	3.70	69.60	70.00	3.28	2.30	11.10	1.57
10.50	10.00	3.01	3.70	71.95	70.00	2.25	2.30	10.90	1.39
10.69	10.00	3.39	3.70	70.45	70.00	2.61	2.30	11.27	1.59
10.44	10.00	3.21	3.70	70.63	70.00	2.50	2.30	11.41	1.31
9.69	10.00	2.90	3.70	71.63	70.00	2.35	2.30	12.09	1.34
10.81	10.00	2.90	3.70	70.56	70.00	2.34	2.30	12.00	1.39

POULTRY

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Corno Mills Co.—Continued.		
	4910	2
	4953	3
	4987	1
	5148	1
	5287	1
	5400	1
	5466	1
Average		63
Crowley Rice Milling Co., Crowley, La.		
Chicken Feed (broken rice or screenings, weed seeds and rice hulls)	2720	1
Cyphers Incubator Co., Kansas City, Mo.		
Developing Food	2659	1
Scratching Food	2661	1
R. V. Glass, Jr., New Orleans, La.		
Chicken Feed	3420	1
	3768	1
	4185	1
	4477	1
	4979	1
	5296	1
Average		6
B. F. Glover and Son Commission Co., New Orleans, La.		
New Basin Chicken Feed (contains sweepings, corn, oats, etc.)	2214	4
	2267	1
	2472	2
	2693	2
	2747	1
	2836	1
	3133	1
	3539	2
	3711	1

FEEDS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
10.00	10.00	3.14	3.70	71.13	70.00	2.54	2.30	11.73	1.45
9.81	10.00	2.76	3.70	72.98	70.00	2.18	2.30	10.70	1.57
10.06	10.00	2.95	3.70	72.96	70.00	2.41	2.30	10.01	1.61
9.88	10.00	2.92	3.70	71.33	70.00	2.40	2.30	11.84	1.63
9.81	10.00	3.11	3.70	73.37	70.00	2.75	2.30	9.16	1.80
10.13	10.00	2.73	3.70	71.29	70.00	2.80	2.30	11.17	1.88
10.25	10.00	3.26	3.70	71.33	70.00	2.85	2.30	10.72	1.59
10.25	10.00	3.20	3.70	71.36	70.00	2.51	2.30	11.77	1.51
9.61	9.62	2.20	3.00	68.79	45.97	2.31	6.75	11.60	5.49
12.94	10.09	4.52	3.00	63.91	61.30	4.51	3.90	12.45	1.67
12.10	11.05	3.15	3.00	68.22	60.30	2.76	3.59	12.19	1.58
8.69	9.00	2.83	3.35	60.65	61.51	3.15	4.47	10.88	13.30
8.56	9.00	3.00	3.35	62.90	61.51	2.80	4.47	11.48	11.26
8.81	9.00	2.87	3.35	59.83	61.51	2.73	4.47	9.85	15.91
9.06	9.00	3.67	3.35	71.65	61.51	3.53	4.47	9.66	2.43
9.94	9.00	3.13	3.35	69.95	61.51	3.14	4.47	10.25	3.59
9.56	9.00	2.56	3.35	59.48	61.51	3.29	4.47	8.62	16.49
9.10	9.00	3.01	3.35	64.08	61.51	3.11	4.47	10.12	10.58
10.81	5.00	3.07	2.00	66.70	70.00	5.40	30.00	10.73	3.29
9.13	5.00	3.66	2.00	68.82	70.00	3.13	30.00	12.41	2.85
11.63	5.00	2.68	2.00	66.72	70.00	5.10	30.00	11.19	2.68
9.46	5.00	3.88	2.00	67.64	70.00	4.14	30.00	12.28	2.60
9.81	5.00	3.98	2.00	62.43	70.00	5.55	30.00	12.91	5.32
9.56	5.00	3.47	2.00	66.47	70.00	5.89	30.00	12.24	2.37
11.50	5.00	3.76	2.00	61.76	70.00	5.85	30.00	11.33	5.80
9.81	5.00	3.50	2.00	65.71	70.00	6.25	30.00	10.88	3.85
10.63	5.00	2.60	2.00	69.47	70.00	3.67	30.00	11.11	2.52

POULTRY

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
B. F. Glover and Son Commission Co.—Continued.		
	3854	1
	3999	1
	4090	1
	4243	2
	4387	1
	4578	1
	4691	1
	4873	1
	4984	1
	5116	2
	5289	1
	5370	1
Average		29
Good Luck Mills, St. Louis, Mo.		
Good Luck Mill Feed (chicken scratch size)	4816	1
	5044	1
	5079	2
	5150	1
Average		5
Hugo and Sullivan, New Orleans, La.		
Chick Mix (contains corn refuse, oat hulls and straw)	2479	2
	2615	1
	3205	1
	4202	1
	4989	1
Average		6
Lake Arthur Rice Milling Co., Lake Arthur, La.		
Chicken Feed	3419	1
Quaker Oats Co., Chicago, Ill.		
Schumacher Scratching Grains	2763	1
	3807	1
	3939	1
	4141	1

FEEDS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
9.13	5.00	3.31	2.00	66.08	70.00	4.67	30.00	11.98	4.83
10.94	5.00	3.42	2.00	65.77	70.00	6.10	30.00	9.99	3.78
10.25	5.00	3.76	2.00	64.75	70.00	8.50	30.00	9.44	3.30
9.87	5.00	3.44	2.00	62.02	70.00	10.60	30.00	10.51	3.56
10.25	5.00	3.63	2.00	67.41	70.00	6.22	30.00	9.08	3.41
9.88	5.00	2.98	2.00	67.86	70.00	6.77	30.00	8.94	3.57
10.00	5.00	3.48	2.00	67.27	70.00	5.97	30.00	9.24	4.04
9.44	5.00	3.55	2.00	66.07	70.00	6.08	30.00	9.96	4.90
11.19	5.00	3.36	2.00	61.81	70.00	9.96	30.00	9.27	4.41
10.00	5.00	3.58	2.00	66.69	70.00	6.06	30.00	10.63	3.04
10.31	5.00	3.25	2.00	67.55	70.00	5.11	30.00	8.59	5.19
10.16	5.00	3.55	2.00	65.16	70.00	7.30	30.00	9.15	4.68
10.18	5.00	3.42	2.00	65.92	70.00	6.11	30.00	10.56	3.81
10.06	9.00	2.87	3.00	65.60	60.00	3.93	6.00	7.83	9.71
9.50	9.00	2.95	3.00	65.14	60.00	3.94	6.00	8.22	10.25
9.63	9.00	2.90	3.00	67.96	60.00	3.26	6.00	11.21	5.04
9.38	9.00	3.17	3.00	66.68	60.00	2.84	6.00	10.37	7.56
9.66	9.00	2.97	3.00	66.34	60.00	3.49	6.00	9.40	8.14
10.88	14.39	3.59	6.64	62.17	21.99	5.77	12.28	10.46	7.13
9.86	14.39	2.19	6.64	59.44	21.99	3.27	12.28	8.71	16.53
10.69	14.39	2.52	6.64	62.66	21.99	2.95	12.28	12.32	8.86
9.75	14.39	2.78	6.64	60.97	21.99	4.08	12.28	9.72	12.70
9.69	14.39	2.17	6.64	59.79	21.99	3.71	12.28	8.31	16.33
10.17	14.39	2.65	6.64	61.01	21.99	3.96	12.28	9.90	12.31
8.44	5.00	2.00	1.50	70.22	40.00	2.00	25.00	12.26	5.08
10.31	10.50	3.05	3.00	66.26	60.50	3.69	7.50	11.67	5.02
11.13	10.50	3.01	3.00	68.90	60.50	3.53	7.50	11.68	1.75
11.31	10.50	3.21	3.00	69.04	60.50	3.58	7.50	11.19	1.67
9.87	10.50	3.19	3.00	68.87	60.50	3.59	7.50	12.80	1.68

POULTRY

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Quaker Oats Co.—Continued.		
	4878	1
	4991	1
Average		6
Ralston Purina Co., St. Louis, Mo.		
Purina Mill Feed Chick Size	2812	1
	2894	1
	3147	1
	3207	1
	3269	2
	3367	1
	3555	6
	3750	1
	3794	2
	3843	3
	3917	1
	4011	2
	4095	3
	4192	2
	4318	1
	4499	1
	4559	1
	4597	1
	4655	1
	4737	1
	4747	1
	5088	1
	5252	1
	5401	1
Average		37
Purina Pigeon Feed	4686	1
	4018	1
Average		2
Purina Mill Feed Scratch Size	2259	3
	2510	3
	2811	1
	3247	3
	3366	1

FEEDS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
10.13	10.50	3.10	3.00	68.99	60.50	3.85	7.50	12.21	1.72
10.50	10.50	2.90	3.00	71.58	60.50	3.62	7.50	9.54	1.86
——	——	——	——	——	——	——	——	——	——
10.54	10.50	3.08	3.00	68.94	60.50	3.64	7.50	11.51	2.29
12.19	11.00	4.91	3.60	65.08	65.00	4.43	4.00	10.99	2.40
11.75	11.00	3.74	3.60	67.98	65.00	3.49	4.00	10.67	2.37
11.25	11.00	3.04	3.60	67.47	65.00	3.49	4.00	12.89	1.86
11.00	11.00	4.20	3.60	66.28	65.00	3.85	4.00	12.01	2.66
11.38	11.00	3.49	3.60	68.87	65.00	3.03	4.00	11.14	2.09
11.31	11.00	4.05	3.60	70.51	65.00	3.31	4.00	8.83	1.99
12.13	11.00	3.55	3.60	68.11	65.00	3.12	4.00	11.21	1.88
11.00	11.00	3.22	3.60	68.13	65.00	3.13	4.00	12.80	1.72
11.56	11.00	3.76	3.60	68.89	65.00	3.15	4.00	10.86	1.78
11.38	11.00	3.61	3.60	68.40	65.00	3.08	4.00	11.62	1.91
11.06	11.00	4.37	3.60	67.62	65.00	3.90	4.00	10.85	2.20
11.31	11.00	3.91	3.60	68.51	65.00	3.40	4.00	10.98	1.89
11.63	11.00	3.85	3.60	68.21	65.00	3.52	4.00	10.92	1.87
11.00	11.00	3.46	3.60	70.24	65.00	3.19	4.00	10.16	1.95
11.19	11.00	3.50	3.60	69.42	65.00	3.51	4.00	10.15	2.23
11.50	11.00	3.57	3.60	68.04	65.00	3.41	4.00	10.69	2.79
11.75	11.00	4.14	3.60	67.82	65.00	3.43	4.00	10.88	1.98
11.50	11.00	3.60	3.60	68.59	65.00	3.55	4.00	10.36	2.40
11.56	11.00	3.99	3.60	69.76	65.00	3.37	4.00	9.34	1.98
11.56	11.00	3.80	3.60	68.72	65.00	3.14	4.00	10.78	2.00
11.69	11.00	3.94	3.60	68.74	65.00	3.68	4.00	9.81	2.14
11.81	11.00	4.19	3.60	66.63	65.00	4.01	4.00	11.22	2.14
11.31	11.00	3.48	3.60	68.46	65.00	2.84	4.00	10.98	2.93
11.13	11.00	3.27	3.60	67.35	65.00	3.50	4.00	12.39	2.36
——	——	——	——	——	——	——	——	——	——
11.46	11.00	3.77	3.60	68.24	65.00	3.44	4.00	10.94	2.15
12.00	11.00	2.54	3.60	70.54	65.00	2.88	4.00	10.29	1.75
11.69	11.00	2.91	3.60	70.36	65.00	3.03	4.00	10.05	1.95
——	——	——	——	——	——	——	——	——	——
11.85	11.00	2.73	3.60	70.45	65.00	2.95	4.00	10.17	1.85
12.00	11.00	3.54	3.60	66.65	65.00	4.29	4.00	11.48	2.04
11.06	11.00	3.11	3.60	70.15	65.00	3.02	4.00	11.01	1.65
10.81	11.00	3.70	3.60	69.24	65.00	3.72	4.00	10.84	1.69
11.19	11.00	3.52	3.60	68.69	65.00	2.74	4.00	12.13	1.73
11.56	11.00	3.69	3.60	71.44	65.00	3.25	4.00	8.37	1.69

POULTRY

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Ralston Purina Co.—Continued.		
	3556	6
	3728	2
	3793	2
	3844	3
	3969	3
	4104	2
	4109	2
	4159	3
	4417	1
	4498	1
	4529	2
	4656	1
	4688	1
	4703	2
	4748	1
	4808	1
	4205	2
	4888	1
	2387	1
	4934	1
	5180	1
	5229	1
	5248	2
	5403	1
Average		54
Steinmesch F. and P. S. Co., St. Louis, Mo.		
Steinmesch Early Breakfast Mash	3565	1
	4073	1
	4658	1
	5041	1
Average		4
Steinmesch Extra Quality Chicken Feed	2409	1
	2945	1
	3227	1
	3595	1
	3748	1
	4085	2
Average		7

FEEDS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
12.00	11.00	3.30	3.60	68.39	65.00	2.82	4.00	11.79	1.70
11.25	11.00	3.22	3.60	69.46	65.00	2.88	4.00	11.48	1.71
10.56	11.00	3.30	3.60	70.51	65.00	2.83	4.00	11.17	1.63
10.75	11.00	3.38	3.60	69.85	65.00	2.97	4.00	11.33	1.72
10.88	11.00	3.00	3.60	69.98	65.00	2.80	4.00	11.72	1.62
10.31	11.00	3.13	3.60	71.58	65.00	3.13	4.00	10.13	1.72
10.63	11.00	2.97	3.60	70.84	65.00	2.95	4.00	11.30	1.67
10.38	11.00	3.72	3.60	71.56	65.00	3.17	4.00	9.45	1.72
10.63	11.00	3.59	3.60	71.08	65.00	3.07	4.00	9.90	1.73
10.19	11.00	3.50	3.60	70.39	65.00	3.29	4.00	10.92	1.71
10.31	11.00	3.00	3.60	70.13	65.00	3.06	4.00	11.72	1.78
11.06	11.00	3.23	3.60	69.43	65.00	3.35	4.00	11.04	1.89
10.37	11.00	2.93	3.60	72.36	65.00	3.10	4.00	9.56	1.68
10.50	11.00	3.18	3.60	70.10	65.00	3.94	4.00	10.73	1.85
10.81	11.00	3.80	3.60	69.97	65.00	3.66	4.00	9.82	1.94
9.69	11.00	2.63	3.60	64.68	65.00	3.59	4.00	8.94	10.47
10.44	11.00	4.17	3.60	69.34	65.00	3.65	4.00	10.62	1.78
10.81	11.00	4.16	3.60	68.62	65.00	4.07	4.00	10.25	2.09
12.31	11.00	3.74	3.60	66.79	65.00	3.58	4.00	11.68	1.90
10.88	11.00	3.50	3.60	69.87	65.00	3.83	4.00	9.96	1.96
10.44	11.00	3.97	3.60	68.04	65.00	3.23	4.00	12.39	1.93
14.94	11.00	3.27	3.60	66.75	65.00	3.38	4.00	9.73	1.93
11.00	11.00	3.00	3.60	68.45	65.00	3.38	4.00	12.11	2.06
11.13	11.00	2.76	3.60	68.56	65.00	3.62	4.00	11.79	2.14
—	—	—	—	—	—	—	—	—	—
10.99	11.00	3.38	3.60	69.41	65.00	3.31	4.00	10.80	2.11
16.63	14.10	4.80	3.00	48.12	40.00	10.28	8.00	9.03	11.14
16.25	14.10	4.11	3.00	46.93	40.00	11.12	8.00	11.35	10.24
15.81	14.10	4.96	3.00	39.95	40.00	13.33	8.00	9.23	16.72
16.56	14.10	7.20	3.00	41.13	40.00	14.33	8.00	7.60	13.18
—	—	—	—	—	—	—	—	—	—
16.31	14.10	5.27	3.00	44.04	40.00	12.26	8.00	9.30	12.82
13.00	12.60	5.11	3.10	51.56	30.00	6.77	9.00	9.31	14.25
12.94	12.60	6.55	3.10	54.89	30.00	6.01	9.00	9.60	9.91
12.25	12.60	7.15	3.10	54.19	30.00	5.30	9.00	10.50	10.61
12.56	12.60	7.05	3.10	55.61	30.00	5.43	9.00	10.97	8.38
12.43	12.60	5.03	3.10	58.91	30.00	7.01	9.00	11.67	4.95
12.88	12.60	5.83	3.10	59.35	30.00	6.33	9.00	10.00	5.61
—	—	—	—	—	—	—	—	—	—
12.68	12.60	6.12	3.10	55.76	30.00	6.15	9.00	10.34	8.95

POULTRY

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
Steinmesch F. and P. S. Co.—Continued.		
Select Hen Feed	2946	1
	3225	1
	3594	1
	4074	1
	4659	1
	5452	1
	5039	1
Average		7
Steinmesch Select Pigeon Feed	2944	1
	3234	1
Average		2
United States Rice Milling Co., Crowley, La.		
Chicken Feed (broken rice and weed seeds)	2337	1
	3384	1
Average		2
Valley Milling Co., St. Louis, Mo.		
Acme Chicken Feed	2298	1
	3132	1
	3287	1
	3564	1
	3890	9
	3972	2
	4062	2
	4189	1
	4431	4
	4497	2
	4505	5
	4600	1
	4637	1
	4800	2
	4865	2
	4944	1
	5067	1
	5121	1
	5399	1
Average		39
Otto Weiss Alfalfa Stock Food Co., Witchita, Kan.		
Otto Weiss Chick Feed	3796	2

FEEDS.

PROTEIN		FAT		CARBOHYDRATES		FIBER		WATER	ASH
Found %	Guarant'd	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
10.25	11.00	3.43	3.00	57.48	30.00	4.38	9.00	10.35	14.11
11.38	11.00	3.80	3.00	62.01	30.00	4.24	9.00	11.34	7.23
10.69	11.00	3.45	3.00	62.06	30.00	4.71	9.00	11.63	7.46
10.75	11.00	3.61	3.00	62.66	30.00	5.42	9.00	10.66	6.90
10.94	11.00	3.50	3.00	63.76	30.00	5.21	9.00	10.70	5.89
9.88	11.00	2.98	3.00	58.18	30.00	4.80	9.00	10.17	13.99
10.50	11.00	2.81	3.00	60.89	30.00	5.70	9.00	9.36	10.74
10.63	11.00	3.37	3.00	61.00	30.00	4.92	9.00	10.60	9.48
11.31	12.00	3.67	3.60	62.89	30.00	4.42	9.00	11.55	6.16
12.00	12.00	5.13	3.60	60.72	30.00	4.52	9.00	11.18	6.45
11.66	12.00	4.40	3.60	61.80	30.00	4.47	9.00	11.37	6.30
9.31	7.94	2.69	2.42	64.81	55.87	7.73	6.40	12.60	2.86
10.25	7.94	2.31	2.42	65.28	55.87	2.75	6.40	11.74	7.67
9.78	7.94	2.50	2.42	65.05	55.87	5.24	6.40	12.17	5.26
10.00	6.50	4.52	3.00	64.07	55.00	2.52	15.00	10.29	8.60
10.00	6.50	2.96	3.00	61.96	55.00	2.64	15.00	12.65	9.79
11.06	6.50	3.03	3.00	61.12	55.00	3.25	15.00	11.54	10.00
10.81	6.50	3.21	3.00	64.36	55.00	2.92	15.00	10.83	7.87
11.44	6.50	3.24	3.00	66.82	55.00	3.24	15.00	10.25	5.01
10.31	6.50	3.51	3.00	67.76	55.00	2.45	15.00	10.05	5.92
10.69	6.50	2.99	3.00	61.67	55.00	3.24	15.00	10.53	10.88
10.81	6.50	3.09	3.00	62.89	55.00	3.18	15.00	9.38	10.65
10.06	6.50	2.91	3.00	65.66	55.00	2.84	15.00	9.76	8.77
10.13	6.50	3.37	3.00	69.77	55.00	2.47	15.00	10.56	3.70
9.31	6.50	3.28	3.00	64.73	55.00	3.05	15.00	9.28	10.35
9.40	6.50	2.86	3.00	63.50	55.00	2.96	15.00	9.40	11.88
10.56	6.50	3.10	3.00	65.93	55.00	3.21	15.00	9.15	8.05
9.88	6.50	3.42	3.00	65.66	55.00	3.27	15.00	9.93	7.84
9.87	6.50	2.93	3.00	68.41	55.00	2.54	15.00	10.18	6.07
9.88	6.50	2.97	3.00	70.19	55.00	2.46	15.00	10.15	4.35
10.50	6.50	3.23	3.00	68.79	55.00	3.61	15.00	10.86	3.01
9.56	6.50	3.03	3.00	62.27	55.00	2.98	15.00	9.41	12.75
10.44	6.50	3.85	3.00	66.50	55.00	3.50	15.00	10.43	5.28
10.25	6.50	3.24	3.00	65.37	55.00	2.96	15.00	10.24	7.94
12.19	11.02	2.81	2.76	63.74	61.52	2.70	2.63	9.70	8.86

Name of Manufacturer or Jobber and Brand	Station Number	Number of samples composited
POULTRY		
Otto Weiss Alfalfa Stock Food Co.—Continued.		
	4339	1
	4779	1
Average		4
Otto Weiss Hen Feed	3504	1
	3795	2
	4778	1
	5165	1
Average		5
BEEF		
Darling and Co., Chicago, Ill.		
Beef Scraps	2392	2
	2934	1
	3599	1
	4069	1
	4662	1
	5054	1
Average		7
Swift and Co., Ltd., Chicago, Ill.		
Beef Scraps	2658	1
	4936	1
Average		2
BLOOD		
Swift and Co., Ltd., Fort Worth, Tex.		
Swift's Blood Meal	3833	1
	4265	1
Average		2
MISCELLANEOUS		
National Rice Mill Co., New Orleans, La.		
Rice Hog Feed (rice screenings containing weed seeds)	2303	1
Ralston Purina Co., St. Louis, Mo.		
Alfalfa Meal	4070	1

PROTEIN		FAT		CARBOHY-DRATES		FIBER		WATER	ASH
Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Guarant'd %	Found %	Found %
FEEDS.									
11.06	11.02	2.28	2.76	60.66	61.52	2.34	2.63	9.03	14.63
12.00	11.02	2.53	2.76	61.67	61.52	3.12	2.63	9.77	10.91
11.75	11.02	2.54	2.76	62.03	61.52	2.72	2.63	9.50	11.46
11.81	10.59	3.56	3.58	66.16	59.28	2.75	2.18	11.48	4.24
11.38	10.59	4.10	3.58	66.84	59.28	2.57	2.18	9.73	5.38
10.88	10.59	3.01	3.58	70.55	59.28	3.04	2.18	10.85	1.67
10.25	10.59	3.11	3.58	65.29	59.28	2.27	2.18	9.38	9.70
11.08	10.59	3.44	3.58	67.21	59.28	2.66	2.18	10.36	5.25
SCRAPS.									
56.50	55.65	14.18	10.15						
55.31	55.65	13.30	10.15						
61.25	55.65	12.46	10.15						
59.44	55.65	12.04	10.15						
59.13	55.65	11.32	10.15						
55.25	55.65	12.91	10.15						
57.81	55.65	12.70	10.15						
54.71	55.00	14.72	10.00						
54.19	55.00	15.49	10.00						
54.45	55.00	15.11	10.00						
MEAL.									
86.56	87.00								
82.75	87.00								
84.66	87.00								
FEEDS.									
11.00	7.04	4.93	0.04	68.01	58.00	1.73	10.00	11.17	3.16
15.37	15.01	1.50	1.50	35.00	40.00	26.63	29.50	12.70	8.80

630.7
L93B

La. Bulletin No. 115. May, 1909.

Agricultural Experiment Station

OF THE

Louisiana State University and A. & M. College.

BATON ROUGE.

THE PRINCIPLES AND PRACTICE OF FEEDING INCLUDING OUR AVAILABLE STOCK FOODS.

W. H. DALRYMPLE, M. R. C. V. S.

THE NEW ADVOCATE, OFFICIAL JOURNAL

AGRIC. ECON. LIBRARY
LOUISIANA STATE UNIVERSITY

Louisiana State University and A. & M. College

Louisiana State Board of Agriculture and Immigration

EX-OFFICIO.

GOVERNOR JARED Y. SANDERS, *President.*
HENRY L. FUQUA, *Vice President of Board of Supervisors.*
CHAS. SCHULER, *Commissioner of Agriculture and Immigration.*
THOMAS D. BOYD, *President State University.*
W. R. DODSON, *Director Experiment Stations.*

MEMBERS.

R. S. Moore, Plaquemines.
Henry Gerac, Lafayette.
John T. Cole, Monroe.
John J. Henderson, Lagan.
J. E. Bullard, Belmont.
R. E. Thompson, Wilson.
Jeff D. Marks, Crowley.

STATION STAFF.

W. R. DODSON, A. B., B. S., Director, Baton Rouge.
HAMILTON P. AGEE, B. S., Assistant Director, Audubon Park, New Orleans.
J. B. GARRETT, B. S., Assistant Director, Calhoun.
S. E. McCLENDON, B. S., Assistant Director, Baton Rouge.
P. A. YODER, Ph. D., Chemist and Sugar Maker, Audubon Park, New Orleans.
W. G. TAGGART, B. S., Assistant Chemist, Audubon Park, New Orleans.
R. E. GRAHAM, B. S., Assistant Chemist, Audubon Park, New Orleans.
WM. G. OWEN, B. S., Bacteriologist, Audubon Park, New Orleans.
J. K. McHUGH, Secretary and Stenographer, Audubon Park, New Orleans.
G. D. HARRIS, M. S., M. A., Geologist, Baton Rouge.
J. E. HALLIGAN, B. S., Chemist, Baton Rouge.
H. L. GREEN, B. S., Assistant Chemist, Baton Rouge.
A. P. KERR, B. S., Assistant Chemist, Baton Rouge.
J. C. SUMMERS, B. S., Assistant Chemist, Baton Rouge.
R. BAUS, B. S., Assistant Chemist, Baton Rouge.
R. G. FULLER, B. S., Assistant Chemist, Baton Rouge.
W. D. REID, B. S., Assistant Chemist, Baton Rouge.
R. G. TILLERY, B. S., Assistant Chemist, Baton Rouge.
ROGER P. SWIRE, Treasurer, Baton Rouge.
WILMON NEWELL, M. S., Entomologist, Baton Rouge.
G. L. TIEBOUT, B. S., Horticulturist, Baton Rouge.
W. H. DALRYMPLE, M. R. C. V. S., Veterinarian, Baton Rouge.
C. W. EDGERTON, Ph. D., Plant Pathologist, Baton Rouge.
J. T. TANNER, B. A., Secretary and Stenographer, Baton Rouge.
IVY WATSON, Farm Manager, Calhoun.
E. J. WATSON, Horticulturist, Calhoun.
J. G. LEE, JR., B. S., in Charge of Feeding Experiments, Baton Rouge.
E. W. KERR, M. E., Professor Mechanical Engineering, Baton Rouge.
E. M. PERCY, B. S., Assistant Mechanical Engineer, Baton Rouge.
T. C. PAULSEN, B. S., M. D. C., Assistant Veterinarian and Bacteriologist.

THE PRINCIPLES AND PRACTICE OF FEEDING

INCLUDING

OUR AVAILABLE STOCK FOODS

By W. H. Dalrymple.

Food, in the broad sense of the term, is the material which is taken into the animal body to build up its tissues and to yield energy. The act of living brings into activity all of the vital processes, which, in reality, means work. In fact, life is impossible without work; but the work spoken of here has special reference to that which every vital act produces. Every movement of every organ in the body; the very act of breathing; every contraction of the heart in forcing the vital fluid through the arterial and other channels; the tension brought upon the muscles in the act of standing; the contraction and relaxation of those same muscles in progression; the effort produced in the process of chewing, and of digestion in general, and so forth, all call for work of varied degrees of intensity; which, in other words, is an expenditure of vital force or energy, and which has to be conserved, built up, or replaced from the outside by means of suitable nutrients contained in the different materials which we call food.

Deprive the animal economy of nourishment for any length of time, it will exist upon the nutrient material already built up, or incorporated, in its own tissues so long as it will last. But gradually emaciation will take place, and death from inanition, or starvation, will ultimately result.

Food, then, is as absolutely essential to the life, development and energy of the animal machine as fuel is to the movement of the steam-engine. It is converted into heat and energy in the former just as fuel is in the latter—by a process of oxidation. To maintain a healthy or normal equilibrium, however, food has to be regularly supplied the animal so as to replace the tissues that are constantly being wasted, and the energy that is constantly being expended, as the result of work.

What to feed and how to feed it, in order to obtain the most satisfactory results at the least possible cost, however, has been and always will be one of the chief economic problems confronting the feeder of live stock.

The fact is well known to all who have made a study of the economic feeding of farm animals, that the "feed department" calls for the expenditure of more money than any other connected with the ownership of work stock especially.

COTTON.—The Source of our Cotton Seed Meal.

Those who feed intelligently, that is, are governed by an intelligent conception of the physiologic requirements of animals performing different grades of labor, may be said to belong to the "great minority;" and in consequence of the want of this special knowledge there is frequently an enormous amount of unnecessary loss in various ways. For example:

(1) It is frequently the case that animals receive more food than is necessary for their most perfect health and working condition. There being a limit to the digestive powers, food

that is partaken of above that required for proper maintenance (according to the class of animal and the work demanded), not only overtaxes the digestive organs and, consequently, excites disease, but is an absolute waste.

(2) An insufficient quantity, on the other hand, causes loss by producing debility, through want of the necessary nutrition, and consequent inability to perform the desired amount of work.

LESPEDEZA HAY.—Experiment Station, Baton Rouge, La.

(3) Food that is not properly balanced, with regard to its digestible nutrients, causes loss by destroying the equilibrium (of those nutrients) demanded by the animal economy for its proper maintenance, so that one set of tissues may be excessively nourished, while others, and those, perhaps, the more important, do not receive a sufficiency. As an illustration: A ration for a work horse or mule may be so badly balanced (one-sided), that instead of having a sufficient quantity of nutrients to develop muscular strength, it may contain an undue proportion of those which go to form fat, and hence bring about a condition of obesity, combined with want of muscular energy, that is inimical to the performance of excessive muscular effort (hard work) required of an animal of this class. And, conversely, when fat production is the object sought, the fat-form-

ing nutrients may be so deficient, with an excess of muscle-forming constituents, as to inhibit the production of the desired results, etc.

Louisiana's possibilities in the matter of stock food production, both as regards direct products and by-products, may be said to be unlimited. In fact, with the valuable by-products of her cotton-oil mills, rice mills and sugar factories added to her store of natural wealth in grains and leguminous forage crops, she may be said to have ideal conditions for the raising and feeding of live stock of all kinds.

Bulletin No. 86, entitled, "Our Available Stock Foods," was in such demand from its issuance that it has become exhausted, and, to meet the requests for information along this important line, the Station has prepared this publication to take its place. Like No. 86, it is the purpose of this bulletin to draw the attention of our stock-owners to our available feeding materials, and how they may be intelligently utilized to the best advantage. It is to be hoped that the information given may have been presented in such a manner as to be both acceptable and intelligible to those in need of it, as the subject is one of the greatest import to the live stock interests of the State.

Before entering upon an enumeration, etc., of our available feeding materials, it will be necessary to refer, briefly, to a few of the technicalities connected with the principles and practice of feeding, which the feeder ought to understand in order that he may be able to intelligently apply the principles to the practice; or, in other words, know what he is doing; why he is doing it, and the results it is reasonable for him to expect.

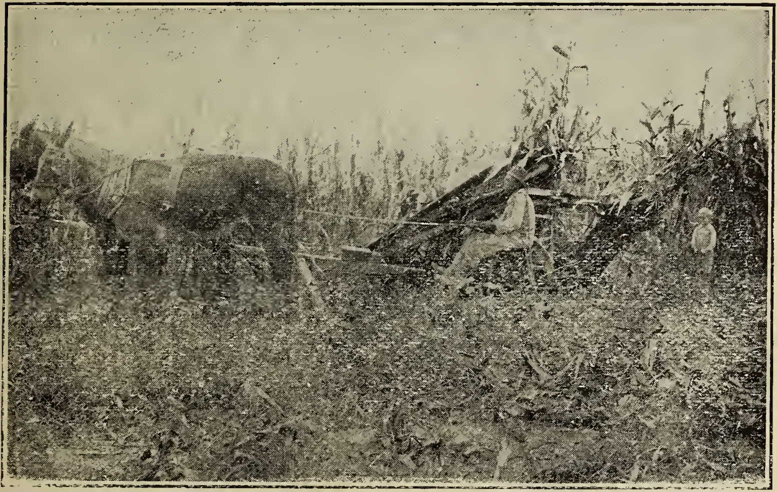
In the first place, the body of the living animal contains, or is made up of, a number of substances very similar to those found in plants, such as water, nitrogenous matter or protein, fat, and mineral matter. In the act of living, these materials in the animal body are constantly being used up, and if not continually supplied, through the medium of the various plant food products, the animal will, as previously mentioned, gradually become emaciated and, ultimately, die.

In the case of herbivorous animals, such as the common domestic animals of the farm, which all, more or less, subsist on herbage or plants of one kind or another, their food contains an additional group of substances to those mentioned, viz., carbohydrates, or nitrogen-free extract, of which starch and sugar are good examples.

Before being able to build up and nourish the body-tissues of the animal, which are composed of the substances alluded to, the feeder ought to be familiar with the composition of the food materials which have to accomplish the work. These may be mentioned as follows:

(1) WATER.

Everyone who feeds stock may not be altogether conversant with the fact that all food stuffs, no matter how dry they may appear, contain a considerable amount of water, or what may be termed moisture.



HARVESTING CORN.—Experiment Station, Baton Rouge, La.

In grains and dried or cured fodders, like hays, it is estimated at about from 8 to 15 per cent of the weight of the food; in the grasses, and other green foods, it may run as high as 80 per cent; while in roots, such as turnips, rutabagas, stock beets, carrots, etc., 90 per cent of their weight may be reached.

Although water is a very essential part of the animal body, constituting about from 40 to 60 per cent of its live weight, the value of a food material is not considered from the standpoint of the amount of water contained in it, but is based upon its dry matter, or what the chemist terms its water-free content. For example: If 100 pounds of oats, of average sample, are subjected to slow heat, not sufficient to burn them, and afterward weighed, they will be found to have lost 11 pounds, which is the weight of the water they had previously contained. The remaining 89 pounds represents the dry matter. Hence, in computing a ration for an animal, only the water-free substance is considered.

(2) ASH OR MINERAL MATTER.

This can probably best be understood by stating that that which remains over of a sample of food stuff, after its organic matter has been completely burned, is the ash or mineral matter, that had been taken up and stored by the plant during the period of its growth. This ash in the food, which is composed largely of lime, potash, magnesia, soda, iron, etc., serves to supply the mineral matter required by the animal to build up its bony, and other structures.

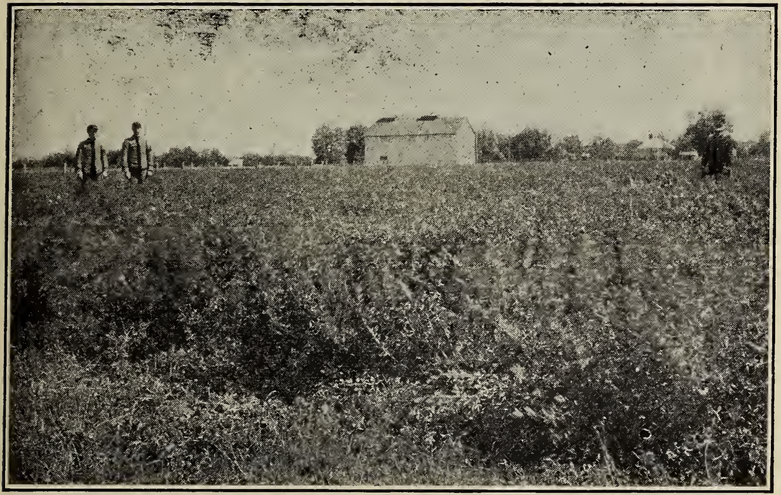
Foods in general, however, contain a sufficiency of mineral matter for the demands of the animal, with the possible exception of common salt (chloride of sodium), which usually has to be supplied.

(3) PROTEIN OR NITROGENOUS SUBSTANCE.

The term protein is from the Greek, and means "to hold the first place." Its name is derived from its occupying the first or most important place in relation to the albuminous principles. The term is here used, however, to characterize the constituents of feeding stuffs containing nitrogen; or, in other words, the nitrogenous compounds of stock foods, both vegetable and animal, are, for the sake of brevity and convenience, designated as a class by the term, PROTEIN.

Belonging to this class of substances is the white of egg, generally termed albumen. There is also vegetable albumen which closely resembles the white of egg, and, like it, is coagulated by heat. Another is gluten, found in the wheat and other grains; another, legumin, the nitrogenous element contained in such plants as peas, beans, alfalfa, lespedeza, clover, etc., belonging to the order, Leguminosæ. The fibrin of meat, and the casein of milk, are both examples of this nitrogenous substance, and cotton seed meal contains quite a high percentage of it.

The use or function of protein in the food, is to build up and repair such parts of the animal body as the muscles (no other class of food constituents can form lean meat), tendons, internal organs, the blood, the skin, etc., and it also assists largely in the formation of milk.



ALFALFA.—Experiment Station, Baton Rouge, La.

(4) NITROGEN-FREE EXTRACT OR CARBO-HYDRATES.

As the first of these names would imply, this fourth group of substances does not contain any nitrogen, and according to the second, it contains carbon, hydrogen and oxygen, with the two latter elements in the proportion to form water, that is, two of the former to one of the latter (H_2O). Examples are, starch, sugar, and the fiber or woody part of plants. The starch, when converted into sugar, and the sugar itself, are quite readily digested and absorbed into the circulation, but the fiber is much less easily digested, although fulfilling a similar function to the extent it is digested.

The largest part of vegetable foods contains this class of nutrients, which, however, are not stored up in the body as carbohydrates, but are either converted (changed) into fat, or used up; that is, oxidized, or burned up, to produce heat and energy.

(5) FAT OR ETHER EXTRACT.

Fat is represented by the true vegetable fats and oils, like the oil in cotton seed or corn, as well as vegetable wax; and as these may be extracted from a water-free sample of food material by means of ether, the name, ether extract, is frequently given to this group.

Fats serve almost the same purpose in the animal economy as do the carbohydrates, only they contain a relatively larger amount of carbon, and give off more heat during their combustion, or burning up, in the body, on that account. For example, if vegetable fats, or plant oils, are burned, they give off 2.25 times as much heat as the carbohydrates (starch, sugar, etc.). So that, for the production of heat and energy in the body, one pound of fat is the equivalent of 2.25 pounds of carbohydrates.

As a general proposition it may be stated, that the foundation principles of nutrition are the same in the case of all animals, and that the function of food is (1) to supply material to build up and repair the tissues of the body; and (2) to yield energy. Hence, the intelligent use of food is directed to supply the waste of materials occasioned by the act of living and the performance of work. And, according to the amount of work performed, and, consequently, the amount of material (tissues) used up or consumed within the body. the amount and ingredients of the food have to be regulated. And, as is well known, combustion, or the creation of heat, produces energy in some form, which takes place when the food is consumed or burned up within the animal body.

Having become familiar with the names of the nutritive substances contained in plants and animals, and required by the latter for their sustenance, the next step is to know the average amount of these the various plants, or food materials, contain. This information has already been obtained, by the chemist, for the great majority of our stock foods; and again referring to oats as an example, are expressed as follows:

CORN AND COW PEAS.—Experiment Station, Baton Rouge, La.

PERCENTAGE COMPOSITION OF OATS.

Water.	Ash.	Protein.	Crude Fiber.	Carbohydrates.	Fat.
11.0	3.0	11.8	9.5	59.7	5.0

This means, that in 100 pounds of oats there are 11 pounds of water; 3 pounds ash; 11.8 pounds protein; 9.5 pounds crude fiber; 59.7 pounds carbohydrates; and 5 pounds of fat. Or, as previously stated, 89 pounds of dry matter, and 11 pounds of water.

The above table shows the percentage of the different nutrients contained in oats, which is very important, but further information is needed, concerning this food stuff, before we are able to realize its true value as a food. In other words, we require to know what percentage of the amounts of the substances mentioned can be digested by the animal. This information has also been furnished by the chemist (the physiological chemist); and again, with oats as an example, is expressed as follows:

AVERAGE COEFFICIENTS OF DIGESTION, OR PERCENTAGE DIGESTIBILITY OF OATS.

Dry Matter.	Protein.	Crude Fiber.	Carbohydrates.	Fat
70	78	20	76	83

This means that 70 per cent of the 89 pounds of dry matter in oats is digestible; 78 per cent of the amount of the protein; 20 per cent of the crude fiber; 76 per cent of the carbohydrates; and 83 per cent of the fat. Or, stated in another way: In the 89 pounds of dry matter contained in 100 pounds of oats there are the following amounts of the principal digestible nutrients:

Protein.	Carbohydrates.	Fat.
lbs.	lbs.	lbs.
9.2	47.3	4.2

It is not sufficient, therefore, to know the chemical composition of a food stuff only, although that is quite important as a guide, but we must also know what per cent of the ingredients are digestible. Because, it is possible for two foods to contain exactly the same amount of chemical substances, and appear to be, theoretically, of the same value; while the difference in the digestibility of the substances may be such as to render one doubly as nutritious as the other, and, in consequence, of much greater value as a food.

There are two very important facts that should be indelibly impressed upon the feeder's mind, viz., (1) that a food stuff should be palatable; and (2) that it should be digestible, which means its power of becoming soluble and of undergoing absorption into the blood, for the purposes of nutrition.

BALANCING THE RATION.

The feeder having acquired an intelligent conception of the different nutritive substances contained in plants, etc. (food stuffs), and the part each plays in building up the various tissues of the animal body, and in producing power and energy; also the average amounts of these substances; and lastly, their percentage digestibility, the next step is to be able to supply them in such quantity and proportion as will best suit the needs of the animal, whether for maintenance, for work of different grades, for the production of flesh, fat, milk, wool, etc. This is known as "balancing the ration;" and the "ration" means the amount or allowance of food given to an animal during twenty-four hours.

For example, it has been ascertained, as the result of careful investigation, that a horse, or mule, weighing 1,000 pounds, and doing what is classed as heavy work, requires for its sustenance, and the performance of such work, a daily food-ration containing the digestible nutrients, as previously alluded to, in about the following proportions, and which is known as a standard for this class of animal:

Dry Matter.	Protein.	Total Carbohydrates.	Nutritive Ratio.
lbs.	lbs.	lbs.	
23	2.3	14.3	1:6.2

Although it is not essential to be mathematically exact, it is just as necessary to have a standard in feeding as in any other work, as a guide, in order to be able to come within reasonable approximation of it.

RED CLOVER.—Experiment Station, Baton Rouge, La.

The following will serve to illustrate a balanced ration approximating the above standard:

lbs.		Dry Matter. lbs.	Digestible Protein. lbs.	Total Carbohydrates. lbs.
6	"Blackstrap" molasses..	4.80	0.00	3.90
8	Corn and cob meal......	6.80	0.35	5.32
2	Cotton seed meal.......	1.84	0.74	0.89
12	Peavine hay............	10.57	1.12	4.92
28		24.01	2.21	15.03

Nutritive ratio, 1:6.8

The fat in this ration does not appear, as it has been reduced to its equivalent in starch (carbohydrate) by multiplying the amount by 2.25 (previously explained) and added to the carbohydrate already present. (It should perhaps be stated here that the nitrogenous bodies in the cane molasses are not expressed under protein, in the above illustration, as they are in the form of amids, and there seems still to be some doubt as to their function as flesh-formers. The percentage in the mill molasses from sugar cane being only 1.40, we have discarded it in the computation, and have relied upon other materials to supply the required amount of protein in the ration.)

The following tabulated matter will serve to illustrate how digestible food nutrients may be wasted when a ration is not approximately balanced, both as to materials and nutrients.

As may be seen by referring to Table No. 1, entitled "Feeding Standards," the amount of dry matter and digestible nutrients required per day by a heavily worked horse or mule weighing 1,000 pounds, is as follows:

Dry Matter. lbs.	Protein. lbs.	Total Carbohydrates. lbs.
23.0	2.3	14.3

ILLUSTRATION NO. 1.

CORN.

lbs.		Dry Matter. lbs.	Protein. lbs.	Total Carbohydrates. lbs.
28	Corn	23.8	2.18	21.4

To be able to approximate the required amount of protein from corn alone, it would be necessary to feed about 28 pounds, which would cause a waste of about 7 pounds in carbohydrates over the amount needed.

STOCK BEETS.—Experiment Station, Baton Rouge, La.

ILLUSTRATION NO. 2.

CORN AND TIMOTHY HAY.

lbs.		Dry Matter. lbs.	Protein. lbs.	Total Carbohydrates. lbs.
15	Corn	13.35	1.185	11.46
36	Timothy hay	31.32	1.008	16.87
		44.67	2.193	28.33

In order to obtain approximately the required amount of protein from 15 pounds of Corn, combined with Timothy (grass) hay, 36 pounds of the latter would have to be fed. This would give an excess of 21.67 pounds of dry matter to be digested by the animal, and a waste of about 14 pounds of total carbohydrates.

ILLUSTRATION NO. 3.

CORN AND ALFALFA HAY.

lbs.		Dry Matter. lbs.	Protein. lbs.	Total Carbohydrates. lbs.
15	Corn	13.35	1.185	11.46
10	Alfalfa hay	9.20	1.100	4.23
		22.55	2.285	15.69

By referring to the standard it will be noted that 15 pounds of Corn and 10 pounds of Alfalfa (leguminous) hay approximate a typically balanced ration (the carbonaceous corn being the complement of the nitrogenous hay, and vice versa), and the total amount of food is much less for the animal to digest, which is a saving on the work of the digestive organs—an important consideration in hard-worked stock.

ILLUSTRATION NO. 4.

OATS.

lbs.		Dry Matter. lbs.	Protein. lbs.	Total Carbohydrates. lbs.
25	Oats	22.25	2.30	14.20

To obtain the required amount of nutrients from Oats alone, 25 pounds would have to be fed. This would not only be too expensive, but would be an excess of grain (concentrates), with a deficiency in roughage, for best results.

ILLUSTRATION NO. 5.

OATS AND TIMOTHY HAY.

lbs.		Dry Matter. lbs.	Protein lbs.	Total Carbohydrates. lbs.
15	Oats	13.35	1.38	8.52
30	Timothy hay	26.10	.84	13.94
		39.45	2.22	22.46

It will be seen that it takes 30 pounds of Timothy hay, added to 15 pounds of Oats, to give about the required amount of protein. This, however, makes too much total dry matter by ~~22~~ /15.4. pounds, and causes a waste of about 8 pounds of total carbohydrates.

COW PEA HAY.—Experiment Station, Baton Rouge, La.

ILLUSTRATION NO. 6.

OATS AND ALFALFA HAY.

lbs.		Dry Matter. lbs.	Protein. lbs.	Total Carbohydrates. lbs.
15	Oats	13.35	1.38	8.52
9	Alfalfa hay	8.28	.99	3.81
		21.63	2.37	12.33

The addition of 9 pounds of Alfalfa hay to 15 pounds of Oats gives about the required amount of protein, but there is a slight deficiency in both total dry matter and total carbohydrates, due to the nitrogenous character of the Alfalfa.

ILLUSTRATION NO. 7.

OATS, TIMOTHY HAY AND ALFALFA HAY.

lbs.		Dry Matter. lbs.	Protein. lbs.	Total Carbohydrates. lbs.
15	Oats	13.35	1.38	8.52
8	Timothy hay	6.96	.22	3.72
7	Alfalfa hay	6.44	.77	2.96
		26.75	2.37	15.20

By the addition of 8 pounds of Timothy hay and 7 pounds Alfalfa hay to 15 pounds of Oats, the typical requirements are approximated with very little waste in carbohydrates. The few pounds extra of dry matter is not a serious discrepancy.

ILLUSTRATION NO. 8.

COTTON SEED MEAL, OATS AND ALFALFA HAY.

lbs.		Dry Matter. lbs.	Protein. lbs.	Total Carbohydrates. lbs.
3	Cotton Seed Meal	2.76	1.12	1.33
11	Oats	9.79	1.01	6.25
15	Alfalfa hay	13.80	1.65	6.34
		26.35	3.78	13.92

The above ration, although close to the carbohydrate requirement, shows a waste of about 1 1-2 pounds of protein, which is the most expensive element in a stock food.

NUTRITIVE RATIO.

A term of importance, used in feeding parlance, is the "nutritive or nutrient ratio." This means the ratio existing between the amount of the digestible protein and the total digestible carbohydrates (C. Hydrates plus the fat reduced), or, in other words, between the digestible nitrogenous and non-nitrogenous ingredients of the ration, and is obtained by dividing the amount of the total carbohydrates by the amount of the protein. For example, the total amount of carbohydrates in the illustration on page 14 is 15.03 pounds. If this is divided by 2.21 pounds, the total amount of the protein, we get 6.8. Or, as it is expressed, 1:6.8 (one to six and eight-tenths, the nutritive ratio of the ration.

THRESHING RICE near Rice Experiment Station, Crowley, La.

WIDTH OF RATIONS.

A ration is said to be narrow or wide according as the relation existing between the digestible protein and the digestible (total) carbohydrates is close or wide. According to some authorities (Jordan, for instance), a narrow ratio is one where the proportion of protein is relatively large, not less, perhaps than 1:5.5 A wide ratio is one where the carbohydrates are very greatly predominant, or in larger proportion, perhaps, than 1:8.0. Anything between the 1:5.5 and 1:8.0 may properly be spoken of as a medium ratio. Frequently the term "one-sided" is used in the case of either a narrow or a wide ration.

The following will serve to illustrate a narrow ration in which the ratio between the protein and the carbohydrates is close:

lbs.		Dry Matter. lbs.	Protein. lbs.	Total Carbohydrates. lbs.
3	Cotton seed meal	2.76	1.12	1.33
11	Oats	9.79	1.01	6.25
15	Alfalfa hay	13.80	1.65	6.34
29		26.35	3.78	13.92

Nutritive ratio, 1:3.8

The nutritive ratio in this illustration, between the 3.78 pounds of digestible protein and the 13.92 pounds of total digestible carbohydrates is as one to three and eight-tenths; or, expressed in figures, 1:3.8. For a similar reason, viz., that the relation between the protein and carbohydrates is close, a narrow ration is sometimes termed a nitrogenous ration.

Conversely, when the ratio between the digestible nutrients of a ration is wide, it is termed a wide ration, or, on account of the excessive relative amount of carbohydrates, a carbonaceous ration.

The following will illustrate a wide ration:

lbs.		Dry Matter. lbs.	Protein. lbs.	Total Carbohydrates. lbs.
10	Molasses	8.00	0.00	6.50
5	Corn	4.45	0.40	5.35
15	Timothy hay	13.05	0.42	6.98
30		25.50	0.82	18.83

Nutritive ratio, 1:23

In the above ration the ratio between the eighty-two one-hundredths (82-100s) of a pound of protein and the 18.83 pounds of carbohydrates is as one to twenty-three, or, 1:23.

The width of rations differs according to the use that is to be made of them. Young growing animals, for example, require food that has a narrow nutritive ratio, which means plenty of protein, for growth and development, the best example of which is, perhaps, milk, with the narrow ratio of about 1:3.7 in the case of cow's milk. Hard-working adult animals require a medium-ratio-ration; while idle animals, or those in which maintenance of condition, only, is desired, can subsist on food of a more carbonaceous nature, or that with a fairly wide nutritive ratio.

Again, in the case of cattle that are being fattened, the width of the nutritive ratio is changed, somewhat, during the different periods of the process in order to obtain the best and most economic results.

OATS.—Experiment Station, Calhoun, La.

Successful stock-feeding is not dependent altogether upon the use of any one particular variety of raw material. It is true that oats is generally conceded to be the food, par excellence, for the horse or mule, because the digestible nutrients happen to be about typically balanced in this cereal. But oats may be looked upon as an expensive foodstuff with us, when they have to be purchased, and, if we can, by mixing together other cheaper, palatable and digestible materials, obtain the same amount of nutritive substances, and in the same nutritive ratio, as exist in oats, we are getting what we want from a cheaper source, besides allowing variety, and, in consequence, practicing economy, but, at the same time, allowing the animal the same quantity of digestible nutrients as is contained in oats. And so it is with other varieties of food stuffs.

The following illustration will serve to elucidate this point:

lbs.		Dry Matter. lbs.	Protein. lbs.	Total Carbohydrates. lbs.		
15	Oats	13.35	1.38	8.52	@ 58c per bu.,	27c
15	Mixed grass and clover hay	13.05	0.93	6.90	@ $15 per ton,	11c
30		26.40	2.31	15.42		38c

Nutritive ratio, 1:6.6

lbs.		Dry Matter. lbs.	Protein. lbs.	Total Carbohydrates. lbs.		
6	Molasses	4.80	0.00	3.90	@ 6c per gal.,	3c
8	Corn and cob meal	6.80	0.35	5.32	@ 56c per bu.,	8c
2	Cotton seed meal..	1.84	0.74	0.89	@$25 per ton,	2½c
12	Peavine hay	10.57	1.12	4.92	@ $15 per ton,	9c
31		24.01	2.21	15.03		22½c

Nutritive ratio, 1:6.8

At the prices quoted, the ration composed of the mixed materials furnishes practically the same amount of dry matter and digestible nutrients as are contained in the oat and hay ration, and at a saving of 15½ cents. This may appear a somewhat insignificant item, in the case of a single animal, and per day, but where large numbers have to be fed, as is the case with the mules on our large sugar estates, it represents the saving of a considerable amount of money in the course of the year.

A point worthy of the feeder's attention, is: That it is not the bulk of the food, or in the form in which it is most familiar to us, that goes to nourish the animal body, but the soluble, digestible nutrients contained in it. In fact the more rational way to base an estimate on the real value of a feeding material is by the amount it contains of these nutrients in digestible form, rather than merely on account of its happening to be oats, corn, hay, etc. It is quite probable, we think, that the time may come when the feeder, instead of talking of purchasing the raw material, as oats, corn, molasses, cotton seed meal, etc., will speak of buying protein, carbohydrates, and fat, which are, in reality, the only nutritious parts of the food; the bulk of material most familiar to us, passing out from the body as residue or inert matter, after having given up its soluble nutritive substances to the blood. And, although a certain amount of bulk in food seems to play an important part in assisting the digestive processes, it is only those nutrients that can enter the blood stream and be carried all over to nourish the various tissues of the body.

FEEDING STANDARDS, OR GUIDES TO THE FEEDER.

The quantity of each of the digestible food nutrients (protein, carbohydrates and fat) required, per 1,000 pounds live weight of animal per day, for a given purpose, and contained in the ingredients composing the ration, is expressed in the term, ''Feeding Standard.''

As previously mentioned, these standards are only intended to guide the feeder in compounding or preparing mixtures of food materials, so that he may be able to make up a ration capable of furnishing, approximately, the amounts and proportions of the digestible nutrients desired in feeding for a specific purpose.

The Feeding Standards given in the following table (No. 1) are chiefly based upon the results of German investigators, the arrangement being that of Armsby, in Circular of Information No. 1, issued by the Pennsylvania State College, and in some respects differ slightly from the Wolf-Lehmann standard.

We quote the following from Prof. W. A. Henry's valuable work on ''Feeds and Feeding:''

''Standards are arranged to meet the requirements of farm animals under normal conditions. The student (or feeder) should not accept the statements in the standards as absolute, but rather as data of a helpful nature to be varied in practice as circumstances suggest. The statements in the column headed 'Dry Matter' should be regarded as approximate only, since the digestive tract of the animal readily adapts itself to variations of 10 per cent or more, from the standard of volume.

''The standards are for animals of normal size. Those of smaller breeds will require more nutrients, amounting in some eases to 0.3 of a pound of nitrogenous, and 1.5 pounds of non-nitrogenous digestible nutrients daily for 1,000 pounds of live weight of animals.

"Narrowing the nutritive ratio in feeding full-grown animals, is for the purpose of lessening the depression of digestibility, to enliven the temperament, or to increase the production of milk at the expense of laying on fat.

"The different standards given for the same class of animals, according to performance, illustrate the manner and direction in which desirable changes should be made.

"In considering the fattening standards the student should bear in mind that the most rapid fattening is usually the most economical, so that the standards given may often be profitably increased.

"Standards for milch cows are given for the middle of the lactation period with animals yielding milk of average composition.

"The standards for growing animals contemplate only a moderate amount of exercise; if much is taken, add 15 per cent—mostly non-nitrogenous nutrients—to the ration. If no exercise is taken, deduct 15 per cent from the standard."

TABLE I—FEEDING STANDARDS.

A—Per day and 1,000 pounds live weight.*

		Dry matter lbs.	Digestible			Nutritive Ratio
			Protein lbs.	Corbohydrates and fat lbs.	Total lbs.	
Oxen at rest in stall		17.5	0.7	8.3	9.0	1:11.9
Wool sheep coarser breeds		20.0	1.2	10.8	12.0	1:9.0
Wool sheep, finer breeds		22.5	1.5	12.0	13.5	1:8.0
Oxen, moderately worked		24.0	1.6	12.0	13.0	1:7.5
Oxen heavily worked		26.0	2.4	14.3	16.7	1:6.0
Horses lightly worked		20.0	1.5	10.4	11.9	1:6.9
Horses moderately worked		21.0	1.7	11.8	13.5	1:6.9
Horses heavily worked		23.0	2.3	14.3	16.6	1:6.2
Milk cows, Wolff's standard		24.0	2.5	13.4	15.9	1:5.4
Milk cows, Wisconsin standard		24.5	2.2	14.9	17.1	1:6.8
Fattening oxen, preliminary period		27.0	2.5	16.1	18.6	1:6.4
Fattening oxen, main period		26.0	3.0	16.4	19.4	1:5.5
Fattening oxen, finishing period		25.0	2.7	16.2	18.9	1:6.0
Fattening sheep, preliminary period		26.0	3.0	16.3	19.3	1:5.4
Fattening sheep, main period		25.0	3.5	15.8	19.3	1:4.5
Fattening swine, preliminary period		36.0	5.0	27.5	32.5	1:5.5
Fattening swine, main period		31.0	4.0	24.0	28.0	1:6.0
Fattening swine, finishing period		23.5	2.7	17.5	20.2	1:6.5
Growing Cattle: Age. Months.	Average live weight per head.					
2- 3	150 lbs	22.0	4.0	18.3	22.3	1:4.6
3- 6	300 lbs	23.4	3.2	15.8	19.0	1:4.9
6-12	500 lbs	24.0	2.5	14.9	17.4	1:6.0
12-18	700 lbs	24.0	2.0	13.9	15.9	1:7.0
18-24	850 lbs	24.0	1.6	12.7	14.3	1:8.0
Growing Sheep:						
5- 6	56 lbs	28.0	3.2	17.4	20.6	1:5.4
6- 8	67 lbs	25.0	2.7	14.7	17.4	1:5.4
8-11	75 lbs	23.0	2.1	12.5	14.6	1:6.0
11-15	82 lbs	22.5	1.7	11.8	13.5	1:7.0
15-20	85 lbs	22.0	1.4	11.1	12.5	1:8.0
Growing fat pigs:						
2- 3	50 lbs	42.0	7.5	30.0	37.5	1:4.0
3- 5	100 lbs	34.0	5.0	25.0	30.0	1:5.0
5- 6	125 lbs	31.5	4.3	23.7	28.0	1:5.5
6- 8	170 lbs	27.0	3.4	20.4	23.8	1:6.0
8-12	250 lbs	21.0	2.5	16.2	18.7	1:6.5

B—Per day and per head.

		Dry matter lbs.	Protein lbs.	Corbohydrates and fat lbs.	Total lbs.	Nutritive Ratio
Growing cattle:						
2- 3	150 lbs	3.3	0.6	2.8	3.4	1:4.6
3- 6	300 lbs	7.0	1.0	4.9	5.9	1:4.9
6-12	500 lbs	12.0	1.3	7.5	8.8	1:6.0
12-18	700 lbs	16.8	1.4	9.7	11.1	1:7.0
18-24	850 lbs	20.4	1.4	11.1	12.5	1:8.0
Growing sheep:						
5- 6	56 lbs	1.6	0.18	0.974	1.154	1:5.4
6- 8	67 lbs	1.7	0.18	0.981	1.161	1:5.4
8-11	75 lbs	1.7	0.16	0.953	1.113	1:6.0
11-15	82 lbs	1.8	0.14	0.975	1.115	1:7.0
15-20	85 lbs	1.9	0.12	0.955	1.075	1:8.0
Growing fat swine:						
2- 3	50 lbs	2.1	0.38	1.50	1.88	1:4.0
3- 5	100 lbs	3.4	0.50	2.50	3.00	1:5.0
5- 6	125 lbs	3.9	0.54	2.96	3.50	1:5.5
6- 8	170 lbs	4.6	0.58	3.47	4.05	1:6.0
8-12	250 lbs	5.2	0.62	4.05	4.67	1:6.5

*The fattening rations are calculated for 1,000 lbs live weight at the beginning of the fattening.

The following table of standards for dairy cows has been compiled, for daily use, from a bulletin by Prof. T. L. Haecker, of the Minnesota Experiment Station, showing in pounds and decimals of a pound the different amounts of digestible nutrients required for a cow weighing 1,000 lbs., and yielding milk as follows:

Lbs. of Milk.	Per cent Butter Fat.	Protein. lbs.	Carbohydrates. lbs.	Fat. lbs.
10	3	1.10	8.81	.15
10	4	1.17	9.14	.17
10	5	1.24	9.47	.19
15	3	1.30	9.72	.21
15	4	1.40	10.21	.25
15	5	1.51	10.71	.28
20	3	1.50	10.62	.38
20	4	1.63	11.28	.42
20	5	1.78	11.94	.47
25	3	1.70	11.54	.45
25	4	1.87	12.35	.50
25	5	1.95	13.18	.56
30	3	1.90	12.43	.51
30	4	2.10	13.42	.58
30	5	2.31	14.41	.65
35	3	2.10	13.35	.58
35	4	2.34	14.49	.66
35	5	2.58	15.65	.74
40	3	2.29	14.24	.65
40	4	2.57	15.56	.74
40	5	2.85	16.88	.83
For each additional 10 lbs.	3	.40	1.81	.14
For each additional 10 lbs.	4	.47	2.14	.16
For each additional 10 lbs	5	.54	2.48	.18

It is necessary, first of all, to provide the amount of feed required for maintenance, which, with the average animal, must contain, for each 100 pounds of live weight, .07 of a pound of digestible protein; .7 of a pound of digestible carbohydrates,, and .01 of a pound of digestible fat. Should a cow weigh 800 pounds, 1,000 pounds, or 1,500 pounds, the figures representing the nutrients for 100 pounds would have to be multiplied by 8, 10 or 15, as the case might be.

Having provided for the maintenance of the cow, the next point is to provide material (nutrients) out of which she can manufacture the solids contained in her milk; it being reasonable to presume that milk showing 5 per cent butter-fat contains more solids than milk showing only 3 per cent, and that it will require relatively more material out of which to make it.

The following two sample rations will serve to illustrate how they may be compounded; the first ration being for a cow weighing 1,000 pounds, and producing, daily, 20 pounds of milk, showing 3 per cent butter fat (see table):

		Dry Matter.	Protein.	Carbohydrates.	Fat.
Lbs.		lbs.	lbs.	lbs.	lbs.
1	Cotton seed meal.....	.92	.37	.17	.12
2	Corn and cob meal....	1.70	.09	1.20	.06
12	Sweet potatoes.......	3.48	.11	2.64	.04
16	Mixed hay...........	14.74	.94.	6.54	.19
		20.84	1.51	10.55	.41

The maintenance requirement for this 1,000-pound cow would be:

Protein.	Carbohydrates.	Fat.
.7	7.0	.1

If these amounts are deducted from the totals of those given in the ration, then the remainder will represent the nutrients required by the cow for milk production.

Sample ration No. 2 is for a cow of similar weight and milk production, but which latter shows 5 per cent butter-fat (see table):

		Dry Matter.	Protein.	Carbohydrates.	Fat.
Lbs.		lbs.	lbs.	lbs.	lbs.
2½	Cotton seed meal....	2.30	.93	.42	.31
1	Corn and cob meal...	.85	.04	.60	.03
6	Sweet potatoes......	1.74	.05	1.32	.02
12	Mixed hay..........	10.45	.71	4.91	.14
7	Blackstrap molasses..	5.46	.00	4.62	.00
		20.80	1.73	11.87	.50

If the same deductions are made here, as in the previous example, the amounts of nutrients for milk production, showing 5 per cent butter-fat, may be ascertained.

Feeding standards should not be considered absolute, but rather as guides, or averages, for the feeder to approximate, and those given in the above tables are no exception to the rule. Besides, it should be remembered that cows differ in their ability to digest and assimilate food and convert it into milk. Consequently there are no rules that can be given that will apply in each and every case, nor take the place of careful observation and intelligent management on the feeder's part.

In order to obtain the nutritive ratios of the different combinations of nutrients shown in the above table, the fat should be multiplied by 2.25, and the product added to the carbohydrates present, to get the total carbohydrates, and this divided by the amount of protein, which has previously been explained under "Fat or Ether Extract."

SYSTEM IN FEEDING.

A feeder may have all the information necessary concerning feeding standards, balanced rations, nutritive ratios, etc., and yet he cannot possibly secure the maximum of good results from the possession of such knowledge unless he employs a rational and intelligent system in the feeding of his animals.

Animals under domestication, such as the live stock of the farm, and more particularly the work horses and mules, are living under artificial conditions in respect to their feeding, and are solely at the mercy of the intelligence, or otherwise, of their owners for the manner, or system, in which their food is supplied to them.

Under natural conditions, the horse, or mule, owing to the anatomical arrangement of its digestive organs, and its physiological requirements, feeds quite often, but partakes of little at a time. The main reason for this is, the relatively small capacity of its stomach—not more, perhaps, than from 14 to 17 quarts—the short time it takes for the stomach to empty itself, and hence the necessity for frequent replenishment.

In order to obtain the most satisfactory results, under domestication, or during work, it is reasonable to presume that the animal's natural method of feeding should be approximated as closely as practicable. During the working season on the plantation or farm this would suggest that the day's ration, or the amount of food required by the animal in twenty-four hours, should be divided into at least three feeds. Some animals may, and do, become habituated to a lesser number of feeds per day with, apparently, satisfactory results. But it is a risky method, because, instead of getting as close as practicable to the animal's natural way of feeding, it is getting further away from it.

After an opportunity, during the past twenty years, of studying and observing the conditions under which many of our work animals are fed, we have no hesitancy in saying that lack of system in feeding is responsible for the major portion of the loss of valuable animals from colic, inflammation of the bowels, etc.

Many who lose valuable mules on the plantations and farms from digestive troubles are wont to place the blame on the kind or class of feed the animals have been given; while, in reality, the blame properly belongs to the unnatural and unintelligent manner in which they receive their feed. A properly-balanced ration of the very best quality of oats, when fed intelligently and systematically, may not induce a case of colic during the natural lifetime of the animal. But if the entire day's ration of oats is fed at one time, instead of its being divided into three parts, it is liable to so derange the digestive apparatus as to set up a fatal case of flatulent colic, because the digestive organs in the horse or mule are not constructed, nor prepared, to "handle" such an excessive quantity of food material all at once. In such a case, are we to blame the oats for the trouble, or the unintelligent manner in which they were fed to the animal? And so it is with other kinds and classes of concentrated feeds; they require system in their administration to prevent indigestion, colic, etc., and to produce the best results in the capacity of the animal for work.

Some years ago the writer was discussing, with an eminent British authority on feeding, the large losses sustained on our plantations as the result of digestive ailments; and, after describing to him the unsystematic method of feeding which at the time prevailed, and, unfortunately, still prevails to too great an extent, his remark was: *"Your main source of trouble seems to be in allowing the animals too much feed at one time, and not feeding them often enough."* And this, apart from the question of inferiority in quality or condition, appears to be the gist of the whole matter with those who suffer loss of work stock as the result of feeding. It is not so much, perhaps, that the animals receive more than is necessary in the total amount for the day, but that that amount is not divided into a sufficient number of feeds for the most perfect digestion of the food.

A point of very great importance for the owner or feeder to bear in mind, therefore, is, that an animal's food may be properly balanced as to its digestible nutrients; it may be correct as to quantity and nutritive ratio; in fact, be perfect in every particular, so far as supplying the needs of the animal is concerned; and yet, if an intelligent system is not employed in the feeding of it, the otherwise perfect requirements may be altogether vitiated.

TABLE No. 2.

In table No. 2 is given the average percentage composition and per cent of digestible matter, of a number of American feeding stuffs, more or less of which are available in Louisiana, the data having been obtained from various sources, notably, Henry's "Feeds and Feeding," Jordan's "Feeding of Farm Animals," and Bulletin No. 163 of the North Carolina Experiment Station, besides that secured from results by our own Stations.

In explanation of the use of Table No. 2, it should be stated that the first division of it is devoted to the average per centage chemical composition of each individual food-stuff; while the division under "Per Cent of Digestible Matter" gives the amount that is digestible of the principal nutrients. For example, if we again turn to oats, we find that it contains, in 100 pounds, 11.8 pounds of protein, 78 per cent of which is digestible; or, a little over 9 pounds of digestible protein in 100 pounds of oats, as shown in the second division.

A table is generally given in works on feeding to show the coefficients of digestibility of the different nutrients in feeds.

We have done away with the necessity for this, however, and, consequently avoided an extra table, by giving the results in the second division. To illustrate: The factor, 78, in the above example, represents the coefficient of digestibility of the crude protein in oats. The 9.3 pounds is the result obtained by multiplying the amount of crude protein by 78, the per cent which its average digestibility represents.

The second division, therefore, obviates the necessity of the feeder having to make the reduction, in the case of each feed, when balancing a ration. The digestive coefficient of each nutrient may, however, be ascertained by dividing the percentage composition into the per cent of digestible matter.

With reference to low-grade sugar cane molasses (blackstrap), it should be stated, in order to avoid confusion, that the data with reference to protein, given in the table, differs slightly from that given in one of our previous illustrations. The figures given in the table are from a number of analyses, made subsequently, by Mr. J. E. Halligan, chemist of the Station.

Halligan's figures show a slightly larger protein content. However, as mentioned in a former part of the bulletin, the nitrogenous bodies (under protein) in molasses, are amids, with a still doubtful value as to their flesh-forming function. So that, in compounding a ration, with blackstrap as an ingredient, the "protein" of the latter is discarded, and the required amount of this nutrient obtained from some other source.

TABLE No. II.

AVERAGE COMPOSITION OF FEEDING STUFFS.

FEED	PERCENTAGE COMPOSITION							PER CENT OF DIGESTIBLE MATTER				
	Dry Matter	Water	Ash	Protein	Carbohydrates (Nitrogen-Free extract)	Crude Fibre	Fat (Ether extract)	Protein	Carbohydrates	Crude Fibre	Fat	
Oats (Grain)	89.0	11.0	3.0	11.8	59.7	9.5	5.0	9.3	44.8	2.8	3.5	
Corn (Grain)	89.4	10.6	1.5	10.3	70.4	2.2	5.0	7.8	65.5	1.3	4.3	
Corn Meal	85.0	15.0	1.4	9.2	68.7	1.9	3.8	5.5	63.9	0.6	3.5	
Corn and Cob Meal	84.9	15.1	1.5	8.5	64.8	6.6	3.5	4.4	57.0	3.0	2.9	
Hominy Chops	88.9	11.1	2.5	9.8	64.5	3.8	8.3	7.5	55.0	.....	6.8	
Wheat (Grain)	89.5	10.5	1.8	11.9	71.9	1.8	2.1	10.2	69.0	.....	1.7	
Wheat Bran	88.1	11.9	5.8	15.4	53.9	9.0	4.0	12.1	37.2	2.0	2.7	
Wheat Middlings	87.9	12.1	3.3	15.6	60.4	4.6	4.0	12.8	51.3	1.7	3.4	
Rye (Grain)	88.4	11.6	1.9	10.6	72.5	1.7	1.7	9.9	67.6	.....	1.1	
Cotton Seed	89.7	10.3	3.5	18.4	24.7	23.2	19.9	12.5	12.3	17.6	17.3	
Cotton Seed (Roasted)	93.9	6.1	5.5	16.8	23.5	20.4	27.7	7.9	12.0	13.5	19.9	
Cotton Seed Meal (Choice)	91.8	8.2	7.2	42.3	23.6	5.6	13.1	37.2	15.1	1.8	12.2	
Rice (Rough)	89.1	10.9	5.5	7.4	64.3	9.3	2.6	.....	.....	.....	.....	
Rice (Clean)	87.2	12.8	0.7	7.5	78.1	0.5	0.4	.....	.....	.....	.....	
Rice Bran, 15 per cent hulls	90.1	9.9	11.3	9.9	44.5	14.5	9.9	6.4	34.8	1.9	5.4	La Station.
Rice Polish	88.5	11.5	3.5	11.1	64.3	3.8	5.8	7.3	59.6	0.8	4.3	
Rice Meal (Pure Bran)	91.4	8.6	8.9	13.3	49.8	8.7	10.7	8.6	38.9	1.1	5.9	
Buckwheat	87.4	12.6	2.7	10.0	64.5	8.7	2.2	7.7	49.0	.....	1.8	
Cane Molasses (Blackstrap)	77.6	22.4	9.3	2.4	65.9	.....	.....	.....	65.9	.....	.....	Halligan, La., Station.
Beet Molasses	79.2	20.8	10.6	9.1	59.5	.....	.....	.....	59.5	.....	.....	
Skimmed Milk (Separator)	9.4	90.6	0.7	3.1	5.3	.....	0.3	2.9	5.2	.....	0.3	
Skimmed Milk (Gravity)	9.6	90.4	0.7	3.3	4.7	.....	0.9	3.1	4.7	.....	0.8	

Buttermilk	9.9	90.1	0.7	4.0	4.0	.....	1.1	3.9	4.0	.....	1.1	
Oat Hay (cut in milk)	85.0	15.0	5.2	9.3	39.0	29.2	2.3	5.0	20.3	12.7	1.4	
Oat Straw	90.8	9.2	5.1	4.0	42.4	37.0	2.3	1.2	18.7	20.0	0.8	
Corn Fodder (leaves)	91.1	8.9	9.7	11.8	41.5	24.7	3.3	5.3	26.3	17.1	2.0	
Corn Fodder (whole plant)	67.8	32.2	4.3	4.8	37.2	20.2	1.3	2.6	23.6	13.8	0.9	
Corn Stover (whole plant, except ears)	77.2	22.8	4.9	5.5	39.9	25.6	1.3	2.8	25.3	17.0	0.7	
Corn Shucks	91.9	8.1	3.4	3.3	51.6	32.8	0.9	1.0	38.6	26.1	0.3	
Wheat Straw	90.4	9.6	4.2	3.4	43.4	38.1	1.3	0.4	16.5	19.8	0.4	
Rye Straw	92.9	7.1	3.2	3.0	46.6	38.9	1.2	0.6	17.2	23.3	0.4	
Rice Straw	88.0	12.0	7.8	5.9	33.7	38.6	2.1	2.7	10.8	22.0	1.0	
Cotton Seed Hulls	88.9	11.1	2.8	4.2	33.4	46.3	2.2	0.25	11.4	21.8	1.7	
Cow Pea Hay	88.1	11.9	8.4	14.4	41.2	21.5	2.5	9.30	29.1	9.2	1.2	
Alfalfa Hay	91.6	8.4	7.4	14.3	42.7	25.0	2.2	10.60	28.2	10.7	0.9	
Soja Bean Hay	88.7	11.3	7.2	15.4	38.6	22.3	5.2	10.90	26.6	13.6	1.5	
Vetch Hay	88.7	11.3	7.9	17.0	36.1	25.4	2.3	12.90	23.8	13.7	1.4	
Peanut Vine Hay (without nuts)	92.4	7.6	10.8	10.7	42.7	23.6	4.6	6.70	29.9	12.3	3.0	
Crimson Clover Hay	90.4	9.6	8.6	15.2	36.6	27.2	2.8	10.50	22.7	12.2	1.2	
Red Clover Hay	84.7	15.3	6.2	12.3	38.1	24.8	3.3	7.60	26.3	12.1	2.0	
Lespedeza Hay	89.7	10.3	4.1	11.7	43.8	26.5	3.6	7.6	31.1	11.1	1.8	Approximate.
Crab Grass Hay	89.7	10.3	7.3	6.9	41.0	32.9	1.6	2.2	21.6	21.2	0.6	
Orchard Grass Hay	90.1	9.9	6.0	8.1	41.0	32.4	2.6	4.9	22.5	19.8	1.4	
Timothy Hay	86.8	13.2	4.4	5.9	45.0	29.0	2.5	2.8	28.3	15.1	1.4	
Bermuda Hay	89.4	10.6	6.4	10.2	48.3	22.4	2.2	4.6	26.1	13.0	0.9	Approximate.
Kentucky Blue Grass Hay	78.8	21.2	6.3	7.8	37.8	23.0	3.9	4.8	37.3	.....	2.0	
Millet Hay (Cat Tail)	89.5	10.5	10.2	9.9	36.6	30.8	2.0	6.2	21.6	20.5	0.9	
Johnson Grass Hay	88.8	10.2	6.1	7.2	45.9	28.5	2.1	3.2	24.8	16.5	0.8	
Corn Silage	20.9	79.1	1.4	1.7	11.0	6.0	0.8	0.9	7.6	3.7	0.7	
Sorghum Silage	23.9	76.1	1.1	0.8	15.3	6.4	0.3	0.6	15.0	.....	0.2	
Soja Bean Silage	25.8	74.2	2.8	4.1	6.9	9.7	2.2	2.7	3.9	4.7	1.3	
Cow Pea Silage	20.7	79.3	2.9	2.7	7.6	6.0	1.5	1.5	5.5	3.1	0.9	
Sorghum (Green)	20.6	79.4	1.1	1.3	11.6	6.1	0.5	0.6	8.6	3.6	0.4	
Corn (Green)	20.7	79.3	1.2	1.8	12.2	5.0	0.5	0.9	9.0	3.0	0.3	
Alfalfa (Green)	28.2	71.8	2.7	4.8	12.3	7.4	1.0	3.9	9.3	3.3	0.5	
Cow Pea (Green)	16.4	83.6	1.7	2.4	7.1	4.8	0.4	1.8	6.0	2.7	0.2	
Lespedeza (Green)	30.0	.....	.....	2.7	14.4	.....	0.6	~~2.7~~	~~14.4~~	~~.....~~	~~0.6~~	

TABLE No. II.—(Continued)

AVERAGE COMPOSITION OF FEEDING STUFFS.

FEED	PERCENTAGE COMPOSITION							PER CENT OF DIGESTIBLE MATTER			
	Dry Matter	Water	Ash	Protein	Carbohydrates (Nitrogen-Free extract)	Crude Fibre	Fat (Ether extract)	Protein	Carbohydrates	Crude Fibre	Fat
Oats (in bloom)	37.8	62.2	2.5	3.4	19.3	11.2	1.4	2.5	12.1	6.7	1.0
Rye (Green)	23.4	76.6	1.8	2.6	6.8	11.6	0.6	2.0	4.8	9.3	0.4
Cabbage	9.5	90.5	1.4	2.3	3.9	1.5	0.4	1.8	*8.2	.....	0.4
Rutabagas	11.4	88.6	1.2	1.2	7.5	1.3	0.2	1.0	7.1	1.0	0.2
Carrots	11.4	88.6	1.0	1.1	7.6	1.3	0.4	0.8	*7.8	.....	0.2
Mangel Wurtzel	9.1	90.9	1.1	1.4	5.5	0.9	0.2	1.1	5.0	0.4	0.1
Rape	15.5	84.5	2.0	2.2	8.3	2.5	0.5	1.5	8.1	.....	0.2
Potatoes (Irish)	21.1	78.9	1.0	2.1	17.3	0.6	0.1	0.9	*16.3	.....	0.1
Potatoes (Sweet)	28.9	71.1	1.0	1.5	24.7	1.3	0.4	0.9	*22.2	.....	0.3
Brewers' Grains (wet)	24.3	75.7	1.0	5.4	12.5	3.8	1.6	3.9	7.7	1.5	1.4
Brewers' Grains (dried)	91.8	8.2	3.6	19.9	51.7	11.0	5.6	15.7	30.0	6.0	5.1
Peanut Meal	89.3	10.7	4.9	47.6	23.7	5.1	8.0	42.9	*22.8	.....	6.9

*Combined Carbohydrates and Fibre.

The following list gives approximately the number of pounds of digestible protein, carbohydrates and fat in one ton each of the feeds named:

	Protein, lbs.	Carbo-hydrates, lbs.	Fat, lbs.
Alfalfa hay	220	792	24
Alfalfa—green	78	254	10
Bermuda hay	115	760	27
Bran	244	772	60
Beet pulp—wet	12	146	...
Corn chop	158	1,334	86
Corn and cob meal	98	1,260	70
Corn stover	36	648	14
Corn silage	18	226	14
Cotton-seed meal	744	338	168
Dried brewers' grains	314	627	102
Ground barley	174	1,312	32
Green peas and oats	36	142	4
Gluten feed	446	962	50
Hominy feed	150	1,104	136
Mangels	22	108	2
Malt sprouts	372	742	34
Middlings	256	1,060	68
Oats	180	946	84
Oat straw	24	772	16
Oat hay	86	928	30
Oil meal—op	586	802	140
Oil meal—np	564	802	56
Pea vine straw	86	646	16
Red clover—green	58	296	14
Redtop hay	96	938	20
Sugar beets	22	204	2
Timothy hay	56	868	28
Wheat	204	1,384	34
Wheat straw	8	726	8

WEIGHT AND MEASURE OF FEED STUFFS.†

The following may be found useful in compounding rations:

	One Quart weighs	One Pound measures
Cotton seed meal*	1.5 lbs.	0.7 qts.
Brewers' grains (dried)*	0.6 "	1.7 "
Wheat middlings (flour)*	1.2 "	0.8 "
Wheat middlings (standard)*	0.8 "	1.3 "
Wheat mixed feed*	0.6 "	1.7 "
Wheat bran*	0.5 "	2.0 "
Whole oats*	1.0 "	1.0 "
Ground oats*	0.7 "	1.4 "
Whole corn*	1.7 "	0.6 "
Corn meal*	1.5 "	0.7 "
Corn and cob meal*	1.4 "	0.7 "
Corn bran*	0.5 "	2.0 "
Hominy meal*	1.1 "	0.9 "
Corn and oat feed (Victor)*	0.7 "	1.4 "
Rice bran	0.8 "	1.3 "
Rice polish	1.2 "	0.8 "
Cotton seed hulls	0.26 "	3.8 "
Alfalfa meal	1.0 "	1.0 "
Molasses (blackstrap)	3.0 "	0.3 "

TABLE No. 3.

Table No. III is given as a convenient "ready reckoner" to enable the feeder to compound rations with as little trouble as possible.

It has been arranged to show the amount of "total dry matter" and "digestible nutrients" in 1. 2. 3. 4. 5. and 10 pounds of a number of available feeding stuffs. based upon their average composition and percentage digestibility.

For example: If the feeder desires to use 10 pounds shelled corn and 12 pounds alfalfa hay for a day's ration, by consulting the table he will find that these two feeds contain the following amount each of dry matter and digestible nutrients:

---

†Louisiana Bulletin 114.
*Bulletin No. 112, Hatch Experiment Station, Amherst, Mass.

lbs.		Dry Matter. lbs.	Protein. lbs.	C. Hydrates. lbs.	Fat. lbs.
10	Corn	8.94	0.78	6.68	0.43
12	Alfalfa hay	10.99	1.27	4.66	0.10
		19.93	2.05	11.34	0.53

In an earlier part of this bulletin it was mentioned that the fat in a foodstuff was equivalent to 2 1-4 (2.25) times its amount in carbohydrates, because when burned up it gave 2 1-4 times as much heat. Consequently, we have to multiply the 0.53 pounds of fat in the above by 2 1-4 to reduce it to its carbohydrate equivalent, and then add it to the carbohydrates already present, thus:

0.53 pounds multiplied by 2.25 equals 1.19 pounds. This added to 11.34 pounds (the amount of carbohydrates present in the ration) gives 11.34 plus 1.19 equals 12.53 pounds of total carbohydrates. *It should be remembered, then, that the amounts given in the "Fat" column have always to be reduced as above explained to get the amount of total carbohydrates, but which need only be done after adding up the amount in the ration as a whole, and as has been done in the above illustration.*

If we desire to know the nutritive ratio of the above ration, we simply divide the amount of total carbohydrates by the amount of digestible protein, thus: 12.53 divided by 2.05 equals 6.1, which is the ratio between the protein and carbohydrates, and taking the former as the unit 1, is expressed as 1:6.1 (one to six and one-tenth).

In compounding rations, it is usually necessary to make trials, with the standard as a guide, and often takes several of these before approximating the standard requirements. Presuming that we wanted to compound a ration for a mule, or horse, weighing 1,000 pounds, and at hard work, we would first consult Table No. 1 to get the standard, which we would find to be:

Dry Matter. lbs.	Protein. lbs.	Total Carbohydrates. lbs.	Nutritive Ratio.
23.0	2.3	14.3	1:6.2

If corn, corn fodder and pea vine hay should be our available feeding materials, we could, by consulting Table No. 3, make the following trial:

lbs		Dry Matter. lbs.	Protein. lbs.	C. Hydrates. lbs.	Fat. lbs.
10	Corn..	8.94	0.78	6.68	0.43
5	Pea vine hay....	4.41	0.47	1.92	0.06
10	Corn fodder.....	9.11	0.53	4.33	0.20
		22.46	1.78	12.93	0.69

Or, after the fat was reduced, would be:

	Dry Matter. lbs.	Protein. lbs.	Total C. Hydrates. lbs.	Nut. Ratio.
	22.46	1.78	14.48	1:8.2
Standard	23.0	2.3	14.3	1:6.2

Although the total carbohydrates are close enough, this trial ration is deficient in protein, and a little below in dry matter (which is not a serious deficiency so long as the required amount of the nutrients is present), with the ratio too wide.

The cheapest available source of protein we have is cotton seed meal. By consulting Table No. 3, we find that one and one-half pounds of this feed contain 1.38 pounds dry matter; 0.56 pounds protein, and 0.65 pounds total carbohydrates, which, when added to the above trial ration, gives the following:

	Dry Matter. lbs.	Protein. lbs.	Total C. Hydrates. lbs.	Nut. Ratio.
	22.46	1.78	14.48	
	1.38	0.56	0.65	
	23.84	2.34	15.13	1:6.4
Standard	23.00	2.30	14.30	1:6.2

By the addition of one and one-half pounds of cotton seed meal to the 10 pounds corn, 5 pounds pea vine hay, and 10 pounds corn fodder, therefore, although the carbohydrates are slightly in excess, we have compounded a ration which comes reasonably close to the standard requirements of a 1,000 pound mule, or horse, doing hard work.

When it is desired to know the digestible nutrients in any amount not given in the table, the result may be obtained by adding or multiplying, as the case may be, some of those mentioned. For instance: If the nutrients in 7 pounds of a foodstuff are wanted, add the amounts under 4 and 3, or 5 and 2, together; if 15 pounds, multiply the amounts given for 5 pounds by three times, or add 10 and 5 together, etc.

It will be noticed that in Table No. 2 "crude fibre" is mentioned, but does not appear in Table No. 3. In the latter the digestible crude fibre has been combined with the digestible carbohydrates, the digestible portions of each being considered of about equal value in the process of nutrition.

A considerable part of the data in Table No. 3 has been arranged from that given in The Bulletin of the North Carolina Department of Agriculture on "Feeding Farm Animals," by Butler and Kilgore.

TABLE No. III.

SHOWING AMOUNT OF DRY MATTER AND DIGESTIBLE MATERIALS IN 1, 2, 3, 4, 5 AND 10 POUNDS OF FEED STUFFS.

FEEDS.	W'g't, Lbs.	Dry Matter, Lbs.	Protein, Lbs.	Carbohydrates, Lbs.	Fats, Lbs.
Oats (horses)............	1	.890	.093	.475	.036
	2	1.780	.186	.950	.072
	3	2.670	.279	1.425	.108
	4	3.560	.372	1.900	.144
	5	4.450	.465	2.375	.180
	10	8.900	.930	4.750	.360
Corn (whole grain—12 experiments with ruminants).	1	.894	.078	.668	.043
	2	1.788	.156	1.336	.086
	3	2.682	.234	2.004	.129
	4	3.576	.312	2.672	.172
	5	4.470	.390	3.340	.215
	10	8.940	.780	6.680	.430
Corn meal (5 experiments with ruminants).	1	.850	.055	.639	.035
	2	1.700	.110	1.278	.070
	3	2.550	.165	1.917	.105
	4	3.400	.220	2.556	.140
	5	4.250	.275	3.195	.175
	10	8.500	.550	6.390	.350
Corn and cob meal (ruminants).	1	.849	.044	.600	.029
	2	1.698	.088	1.200	.058
	3	2.547	.132	1.800	.087
	4	3.396	.176	2.400	.116
	5	4.245	.220	3.000	.145
	10	8.490	.440	6.000	.290
Hominy chops............	1	.889	.075	.552	.068
	2	1.778	.150	1.104	.136
	3	2.667	.225	1.656	.204
	4	3.556	.300	2.208	.272
	5	4.445	.375	2.760	.340
	10	8.890	.750	5.520	.680
Wheat	1	.895	.102	.692	.017
	2	1.790	.204	1.384	.034
	3	2.685	.306	2.076	.051
	4	3.580	.408	2.768	.068
	5	4.475	.510	3.460	.085
	10	8.950	1.020	6.920	.170
Wheat bran..............	1	.881	.121	.392	.027
	2	1.762	.242	.784	.054
	3	2.643	.363	1.176	.081
	4	3.524	.484	1.568	.108
	5	4.405	.605	1.960	.135
	10	8.810	1.210	3.920	.270

TABLE III—Continued.

FEEDS.	W'g't, Lbs.	Dry Matter, Lbs.	Protein, Lbs.	Carbohydrates, Lbs.	Fats, Lbs.
Wheat middlings..........	1	.879	.128	.530	.034
	2	1.758	.256	1.060	.068
	3	2.637	.384	1.590	.102
	4	3.516	.512	2.120	.136
	5	4.395	.640	2.650	.170
	10	8.790	1.280	5.300	.340
Rye	1	.884	.099	.676	.011
	2	1.768	.198	1.352	.022
	3	2.652	.297	2.028	.033
	4	3.536	.396	2.704	.044
	5	4.420	.495	3.380	.055
	10	8.840	.990	6.760	.110
Cotton Seed (raw)........	1	.897	.125	.300	.173
	2	1.794	.250	.600	.346
	3	2.691	.375	.900	.519
	4	3.588	.500	1.200	.692
	5	4.485	.625	1.500	.865
	10	8.970	1.250	3.000	1.730
Cotton seed (roasted)....	1	.94	.08	.26	.20
	2	1.88	.16	.52	.40
	3	2.82	.24	.78	.60
	4	3.76	.32	1.04	.80
	5	4.70	.40	1.10	1.00
	10	9.40	.80	2.20	2.00
Cotton seed meal (ruminants)—choice.	1	.918	.372	.169	.122
	2	1.836	.744	.338	.244
	3	2.754	1.116	.507	.366
	4	3.672	1.488	.676	.488
	5	4.590	1.860	.845	.610
	10	9.180	3.720	1.690	1.220
Buckwheat	1	.874	.077	.492	.018
	2	1.748	.154	.984	.036
	3	2.622	.231	1.476	.054
	4	3.496	.308	1.968	.072
	5	4.370	.385	2.460	.090
	10	8.740	.770	4.920	.180
Skimmed milk (separator)	1	.094	.029	.052	.003
	2	.188	.058	.104	.006
	3	.282	.087	.156	.009
	4	.376	.116	.208	.012
	5	.470	.145	.260	.015
	10	.940	.290	.520	.030

TABLE III—Continued.

FEEDS.	W'g't, Lbs.	Dry Matter, Lbs.	Protein, Lbs.	Carbohydrates, Lbs.	Fats, Lbs.
Skimmed milk (gravity)..	1	.096	.031	.047	.008
	2	.192	.062	.094	.016
	3	.288	.093	.141	.024
	4	.384	.124	.188	.032
	5	.480	.155	.235	.040
	10	.960	.310	.470	.080
Buttermilk	1	.099	.039	.040	.011
	2	.198	.078	.080	.022
	3	.297	.117	.120	.033
	4	.386	.156	.160	.044
	5	.485	.195	.200	.055
	10	.990	.390	.400	.110
Oat hay (cut in milk stage)	1	.850	.050	.330	.014
	2	1.700	.100	.660	.028
	3	2.550	.150	.990	.042
	4	3.400	.200	1.320	.056
	5	4.250	.250	1.650	.070
	10	8.500	.500	3.300	.140
Oat straw................	1	.908	.012	.386	.008
	2	1.816	.024	.772	.016
	3	2.724	.036	1.158	.024
	4	3.632	.048	1.544	.032
	5	4.540	.060	1.930	.040
	10	9.080	.120	3.860	.080
Corn fodder (leaves).....	1	.911	.053	.433	.020
	2	1.822	.106	.866	.040
	3	2.733	.159	1.299	.060
	4	3.644	.212	1.732	.080
	5	4.555	.265	2.165	.100
	10	9.110	.530	4.330	.200
Corn fodder (whole plant)	1	.678	.026	.375	.009
	2	1.356	.052	.750	.018
	3	2.034	.078	1.125	.027
	4	2.712	.104	1.500	.036
	5	3.390	.130	1.875	.045
	10	6.780	.260	3.750	.090
Corn stover (whole plant except in ears).	1	.772	.028	.423	.007
	2	1.544	.056	.846	.014
	3	2.316	.084	1.269	.021
	4	3.088	.112	1.692	.028
	5	3.860	.140	2.115	.035
	10	7.720	.280	4.230	.070

TABLE III—Continued.

FEEDS.	W'g't, Lbs.	Dry Matter, Lbs.	Protein, Lbs.	Carbo-hydrates, Lbs.	Fats, Lbs.
Corn husks (shucks).....	1	.919	.010	.647	.003
	2	1.838	.020	1.294	.006
	3	2.757	.030	1.941	.009
	4	3.676	.040	2.588	.012
	5	4.595	.050	3.235	.015
	10	9.190	.100	6.470	.030
Wheat straw.............	1	.904	.004	.363	.004
	2	1.808	.008	.726	.008
	3	2.712	.012	1.089	.012
	4	3.616	.016	1.452	.016
	5	4.520	.020	1.815	.020
	10	9.040	.040	3.630	.040
Rye straw................	1	.929	.006	.406	.004
	2	1.858	.012	.812	.008
	3	2.787	.018	1.218	.012
	4	3.716	.024	1.624	.016
	5	4.645	.030	2.030	.020
	10	9.290	.060	4.060	.040
Cotton seed hulls.........	1	.889	.003	.331	.017
	2	1.778	.006	.662	.034
	3	2.667	.009	.993	.051
	4	3.566	.012	1.324	.068
	5	4.445	.015	1.655	.085
	10	8.890	.030	3.310	.170
Cow pea vine hay........	1	.881	.093	.384	.012
	2	1.762	.186	.768	.024
	3	2.643	.279	1.152	.036
	4	3.524	.372	1.536	.048
	5	4.405	.465	1.920	.060
	10	8.810	.930	3.840	.120
Alfalfa hay...............	1	.916	.106	.389	.009
	2	1.832	.212	.778	.018
	3	2.748	.318	1.167	.027
	4	3.664	.424	1.556	.036
	5	4.580	.530	1.945	.045
	10	9.160	1.060	3.890	.090
Soja bean hay...........	1	.887	.109	.402	.015
	2	1.774	.218	.804	.030
	3	2.661	.327	1.206	.045
	4	3.548	.436	1.608	.060
	5	4.435	.545	2.010	.075
	10	8.870	1.090	4.020	.150

TABLE III—Continued.

FEEDS.	W'g't, Lbs.	Dry Matter, Lbs.	Protein, Lbs.	Carbo-hydrates, Lbs.	Fats, Lbs.
Vetch hay	1	.887	.129	.376	.014
	2	1.774	.258	.752	.028
	3	2.661	.387	1.128	.042
	4	3.548	.516	1.504	.056
	5	4.435	.645	1.880	.070
	10	8.870	1.290	3.760	.140
Peanut-vine hay (without nuts	1	.924	.067	.422	.030
	2	1.848	.134	.844	.060
	3	2.772	.201	1.266	.090
	4	3.696	.268	1.688	.120
	5	4.620	.335	2.110	.150
	10	9.240	.670	4.220	.300
Crimson clover hay	1	.904	.105	.349	.012
	2	1.808	.210	.698	.024
	3	2.712	.315	1.047	.036
	4	3.616	.420	1.396	.048
	5	4.520	.525	1.745	.060
	10	9.040	1.050	3.490	.120
Red clover hay	1	.847	.076	.384	.021
	2	1.694	.152	.768	.042
	3	2.541	.228	1.152	.063
	4	3.388	.304	1.536	.084
	5	4.235	.380	1.920	.105
	10	8.470	.760	3.840	.210
Lespedeza hay	1	.89	.08	.42	.02
	2	1.78	.16	.84	.04
	3	2.67	.24	1.26	.06
	4	3.56	.32	1.68	.08
	5	4.45	.40	2.10	.10
	10	8.90	.80	4.20	.20
Orchard grass hay	1	.901	.049	.423	.014
	2	1.802	.098	.846	.028
	3	2.703	.147	1.269	.042
	4	3.604	.196	1.692	.056
	5	4.505	.245	2.115	.070
	10	9.010	.490	4.230	.140
Timothy hay	1	.868	.028	.434	.014
	2	1.736	.056	.868	.028
	3	2.604	.084	1.302	.042
	4	3.472	.112	1.736	.056
	5	4.340	.140	2.170	.070
	10	8.680	.280	4.340	.140

TABLE III—Continued.

FEEDS.	W'g't, Lbs.	Dry Matter, Lbs.	Protein, Lbs.	Carbo-hydrates, Lbs.	Fats, Lbs.
Crab grass hay...........	1	.897	.022	.428	.006
	2	1.794	.044	.856	.012
	3	2.691	.066	1.284	.018
	4	3.588	.088	1.712	.024
	5	4.485	.110	2.140	.030
	10	8.970	.220	4.280	.060
Millet hay (cat tail)......	1	.895	.062	.421	.009
	2	1.790	.124	.842	.018
	3	2.685	.186	1.263	.027
	4	3.580	.248	1.684	.036
	5	4.475	.310	2.105	.045
	10	8.950	.620	4.210	.090
Johnson grass hay........	1	.89	.03	.41	.008
	2	1.78	.06	.82	.016
	3	2.67	.09	1.23	.024
	4	3.56	.12	1.64	.032
	5	4.45	.15	2.05	.040
	10	8.90	.30	4.10	.080
Corn silage...............	1	.21	.009	.11	.007
	2	.42	.018	.22	.014
	3	.63	.027	.33	.021
	4	.84	.036	.44	.028
	5	1.05	.045	.55	.035
	10	2.10	.090	1.10	.070
Sorghum silage...........	1	.239	.006	.149	.002
	2	.478	.012	.298	.004
	3	.717	.018	.447	.006
	4	.956	.024	.596	.008
	5	1.195	.030	.745	.010
	10	2.390	.060	1.490	.020
Soja bean silage..........	1	.258	.027	.087	.013
	2	.516	.054	.174	.026
	3	.774	.081	.261	.039
	4	1.032	.108	.348	.052
	5	1.290	.135	.435	.065
	10	2.580	.270	.870	.130
Cowpea silage............	1	.207	.015	.086	.010
	2	.414	.030	.172	.020
	3	.621	.045	.258	.030
	4	.828	.060	.344	.040
	5	1.035	.075	.430	.050
	10	2.070	.150	.860	.100

TABLE III—Continued.

FEEDS.	W'g't, Lbs.	Dry Matter, Lbs.	Protein, Lbs.	Carbo-hydrates, Lbs.	Fats, Lbs.
Sorghum (green).........	1	.21	.006	.12	.004
	2	.42	.012	.24	.008
	3	.63	.018	.36	.012
	4	.84	.024	.48	.016
	5	1.05	.030	.60	.020
	10	2.10	.060	1.20	.040
Corn (green).............	1	.21	.009	.12	.003
	2	.42	.018	.24	.006
	3	.63	.027	.36	.009
	4	.84	.036	.48	.012
	5	1.05	.045	.60	.015
	10	2.10	.090	1.20	.030
Oats (green) in bloom....	1	.38	.03	.19	.01
	2	.76	.06	.38	.02
	3	1.14	.09	.57	.03
	4	1.52	.12	.76	.04
	5	1.90	.15	.95	.05
	10	3.80	.30	1.90	.10
Rye (green).............	1	.23	.02	.14	.004
	2	.46	.04	.28	.008
	3	.69	.06	.42	.012
	4	.92	.08	.56	.016
	5	1.15	.10	.70	.020
	10	2.30	.20	.140	.040
Cabbage	1	.10	.02	.08	.004
	2	.20	.04	.16	.008
	3	.30	.06	.24	.012
	4	.40	.08	.32	.016
	5	.50	.10	.40	.020
	10	1.00	.20	.80	.040
Rutabagas	1	.11	.01	.08	.002
	2	.22	.02	.16	.004
	3	.33	.03	.24	.006
	4	.44	.04	.32	.008
	5	.55	.05	.40	.010
	10	1.10	.10	.80	.020
Carrots	1	.11	.008	.08	.002
	2	.22	.016	.16	.004
	3	.33	.024	.24	.006
	4	.44	.032	.32	.008
	5	.55	.040	.40	.010
	10	1.10	.080	.80	.020

TABLE III—Continued.

FEEDS.	W'g't, Lbs.	Dry Matter, Lbs.	Protein, Lbs.	Carbo-hydrates, Lbs.	Fats, Lbs.
Mangel Wurtzel..........	1	.09	.01	.05	.001
	2	.18	.02	.10	.002
	3	.27	.03	.15	.003
	4	.36	.04	.20	.004
	5	.45	.05	.25	.005
	10	.90	.10	.50	.010
Rape	1	.16	.02	.08	.002
	2	.32	.04	.16	.004
	3	.48	.06	.24	.006
	4	.64	.08	.32	.008
	5	.80	.10	.40	.010
	10	1.60	.20	.80	.020
Potatoes, Irish............	1	.21	.009	.16	.001
	2	.42	.018	.32	.002
	3	.63	.027	.48	.003
	4	.84	.036	.64	.004
	5	1.05	.045	.80	.005
	10	2.10	.090	1.60	.010
Potatoes, sweet............	1	.29	.009	.22	.003
	2	.58	.018	.44	.006
	3	.87	.027	.66	.009
	4	1.16	.036	.88	.012
	5	1.45	.045	1.10	.015
	10	2.90	.090	2.20	.030
Brewers' grains, wet......	1	.24	.04	.09	.01
	2	.48	.08	.18	.02
	3	.72	.12	.27	.03
	4	.96	.16	.36	.04
	5	1.20	.20	.45	.05
	10	2.40	.40	.90	.10
Brewers' grains, dry......	1	.92	.16	.36	.05
	2	1.84	.32	.72	.10
	3	2.76	.48	1.08	.15
	4	3.68	.64	1.44	.20
	5	4.60	.80	1.80	.25
	10	9.20	1.60	3.60	.50
Rice (rough).............	1	.89	.....	.....	.....
	2	1.78	.....	.....	.....
	3	2.67	.....	.....	.....
	4	3.56	.....	.....	.....
	5	4.45	.....	.....	.....
	10	8.90	.....	.....	.....

TABLE III—Continued.

FEEDS.	W'g't, Lbs.	Dry Matter, Lbs.	Protein, Lbs.	Carbohydrates, Lbs.	Fats, Lbs.
Rice (clean)............	1	.87	.....	.....	.....
	2	1.74	.....	.....	.....
	3	2.61	.....	.....	.....
	4	3.48	.....	.....	.....
	5	4.35	.....	.....	.....
	10	8.70	.....	.....	.....
Rice bran (15 per cent hulls	1	.90	.06	.37	.05
	2	1.80	.12	.74	.10
	3	2.70	.18	1.11	.15
	4	3.60	.24	1.48	.20
	5	4.50	.30	1.85	.25
	10	9.00	.60	3.70	.50
Rice polish...............	1	.89	.07	.60	.04
	2	1.78	.14	1.20	.08
	3	2.67	.21	1.80	.12
	4	3.56	.28	2.40	.16
	5	4.45	.35	3.00	.20
	10	8.90	.70	6.00	.40
Rice meal (pure bran)....	1	.91	.09	.40	.06
	2	1.82	.18	.80	.12
	3	2.73	.27	1.20	.18
	4	3.64	.36	1.60	.24
	5	4.55	.45	2.00	.30
	10	9.10	.90	4.00	.60
Cane molasses............	1	.78	.....	.66	.....
	2	1.56	.....	1.32	.....
	3	2.34	.....	1.98	.....
	4	3.12	.....	2.64	.....
	5	3.90	.....	3.30	.....
	10	7.80	.....	6.60	.....
Beet molasses............	1	.79	.....	.60	.....
	2	1.58	.....	1.20	.....
	3	2.37	.....	1.80	.....
	4	3.16	.....	2.40	.....
	5	3.95	.....	3.00	.....
	10	7.90	.....	6.00	.....
Rice straw..............	1	.88	.03	.33	.01
	2	1.76	.06	.66	.02
	3	2.64	.09	.99	.03
	4	3.52	.12	1.22	.04
	5	4.40	.15	1.65	.05
	10	8.80	.30	3.30	.10

TABLE III—Continued.

FEEDS.	W'g't, Lbs.	Dry Matter, Lbs.	Protein, Lbs.	Carbo-hydrates, Lbs.	Fats, Lbs.
Bermuda grass hay........	1	.89	.05	.39	.01
	2	1.78	.10	.78	.02
	3	2.67	.15	1.17	.03
	4	3.56	.20	1.56	.04
	5	4.45	.25	1.95	.05
	10	8.90	.50	3.90	.10
Kentucky blue grass hay..	1	.79	.05	.37	.019
	2	1.58	.10	.74	.038
	3	2.37	.15	1.11	.057
	4	3.16	.20	1.48	.076
	5	3.95	.25	1.85	.095
	10	7.90	.50	3.70	.190
Alfalfa (green)...........	1	.28	.04	.13	.005
	2	.56	.08	.26	.010
	3	.84	.12	.39	.015
	4	1.12	.16	.52	.020
	5	1.40	.20	.65	.025
	10	2.80	.40	1.30	.050
Cowpea (green)..........	1	.16	.02	.09	.002
	2	.32	.04	.18	.004
	3	.48	.06	.27	.006
	4	.64	.08	.36	.008
	5	.80	.10	.45	.010
	10	1.60	.20	.90	.020
Peanut meal.............	1	.89	.43	.23	.07
	2	1.78	.86	.46	.14
	3	2.67	1.29	.69	.21
	4	3.56	1.72	.92	.28
	5	4.45	2.15	1.15	.35
	10	8.90	4.30	2.30	.70

A FEW SAMPLE RATIONS WHICH MAY BE COMPOUNDED OF OUR AVAILABLE STOCK FOODS.

Information previously afforded in this bulletin is sufficient to enable the feeder to select for himself the different available stock foods, and to arrange and balance them for his various needs.

To further assist him, however, we have given below a number of sample rations made up of materials given in Tables Nos. 2 and 3.

It should be stated that in all of the rations mentioned, except when otherwise stated, the amount and proportion of the different materials are for the daily requirements of animals per one thousand pounds live weight. In the case of single animals weighing more or less than 1,000 pounds, the amount of the food should be changed in proportion to their weight. This correction may be approximated by adopting the simple "rule of three," although productivity, rather than difference in weight, has to be considered.

Again, animals at work should have their day's ration divided into three parts and given morning, noon and night, with the greater bulk of the hay, or other roughage, along with the night feed. In the case of young or idle animals, this division is not so necessary, as they are generally allowed free access to food of some kind.

When work animals have "off" or idle days, their food should be reduced in quantity.

Animals doing light or medium work should have their food regulated, both as to amount and "balance," according to their needs, as can be seen by referring to the "standards" on Table No. 1.

When cattle are at pasture, only the concentrated part of their rations may be considered, as the former will take the place of the roughage mentioned in the sample rations.

When hogs (swine) have the run of a suitable pasture, the amount of their concentrated food may be reduced.

In order to ascertain the cost of any of the sample rations, it is only necessary to make a simple calculation based upon the current prices of the materials used.

RATIONS FOR HORSES OR MULES PER 1,000 POUNDS LIVE WEIGHT DOING HARD WORK.

Food Materials—

	Pounds.	Total Pounds.
(1)		
Oats (grain)	13	
Peavine hay	15	28
(2)		
Cotton seed meal	3	
Corn meal, or corn and cob meal	11	
Corn Fodder	13	27
(3)		
Cow peas (grain)	4	
Oats (grain)	15	
Corn fodder	10	29
(4)		
Oats (grain)	15	
Mixed grass and clover hay	15	30
(5)		
Corn (grain)	8	
Oats (grain)	7	
Pea vine hay	15	30
(6)		
Cotton seed meal	2	
Corn and cob meal	8	
Molasses (blackstrap)	11	
Pea vine hay	15	36

(The above is something over the standard in amount, but may be used for a 1,200-pound to a 1,300-pound hard-working horse or mule.)

	Pounds.	Total Pounds.
(7)		
Molasses	15	
Alfalfa hay	16	31

(The above ration can best be used by absorbing as much of the molasses as possible with the hay, chopped. Its nutritive ratio is somewhat wider than the standard.)

	Pounds.	Total Pounds.
(8)		
Molasses	6	
Cotton seed meal	2	
Corn and cob meal	8	
Pea vine hay	15	31
(9)		
Oats	2	
Rice bran	3	
Cotton seed meal	2	
Molasses	10	
Pea vine hay	12	29

The following four rations are for a 1,200-pound horse or mule doing hard work:

	Pounds.	Total Pounds.
(10)		
Cotton seed meal	1½	
Rice meal (pure bran)	8	
Corn	8	
Crab grass hay	15	32½
(11)		
Corn	2	
Rice meal (pure bran)	8	
Molasses	8	
Alfalfa hay	15	33
(12)		
Corn	8	
Rice meal (pure bran)	8	
Pea vine hay	15	31
(13)		
Cotton seed meal	2	
Corn and cob meal	11	
Cotton seed hulls	2	
Pea vine, alfalfa, or lespedeza hay	15	30

(For all practical purposes, alfalfa, pea vine and good lespedeza hays may be used interchangeably as roughage.)

RATIONS FOR MILCH COWS, PER 1,000 POUNDS LIVE WEIGHT.

	Pounds.	Total Pounds.
(1)		
Corn, or corn and cob, meal	4	
Pea vine hay	25	29
(2)		
Rice bran	6	
Sweet potatoes	10	
Pea vine hay	20	36
(3)		
Cotton seed meal	4	
Corn, or corn and cob, meal	3	
Corn stover	10	
Crab grass hay	15	32
(4)		
Cotton seed meal	2	
Wheat bran	4	
Corn, or corn and cob, meal	6	
Corn fodder	18	30
(5)		
Cotton seed meal	2	
Corn, or corn and cob, meal	8	
Rice bran	4	
Pea vine hay	15	29
(6)		
Cotton seed meal	3	
Corn and cob meal	3	
Corn stover	6	
Pea vine hay	8	
Corn silage	40	60
(7)		
Cotton Seed meal	3	
Rice bran	8	
Molasses	10	
Mixed grass hay	14	35

(8)	Pounds.	Total Pounds.
Cotton seed meal	2	
Cotton seed hulls	6	
Pea vine hay	10	
Corn stover	11	29

(9)		
Cotton seed meal	2	
Cotton seed hulls	15	
Pea vine hay	20	37

RATIONS FOR FATTENING CATTLE, PER 1,000 POUNDS LIVE WEIGHT.

(1)	Pounds.	Total Pounds.
Cotton seed meal	4 to 8	
Cotton seed hulls	20 to 25	24 to 33

(2)		
Cotton seed meal	6	
Molasses	10	
Cotton seed hulls	22	38

(3)		
Cotton Seed meal	3	
Rice bran	8	
Molasses	10	
Mixed grass hay	14	35

(4)		
Cotton seed meal	4	
Cotton seed hulls	15	
Sorghum silage	25	44

(5)		
Cotton seed	8	
Rice polish	4	
Alfalfa or pea vine hay	5	
Grass (Johnson) hay	10	27

(6)	Pounds.	Total Pounds.
Cotton seed meal	5	
Corn, or corn and cob, meal	10	
Corn fodder	10	
Sweet potatoes	25	50

(7)	Pounds.	Total Pounds.
Cotton seed meal	5	
Corn, or corn and cob, meal	8	
Cotton seed hulls	25	38

RATIONS FOR FATTENING HOGS (SWINE), PER 1,000 POUNDS LIVE WEIGHT.

(1)	Pounds.	Total Pounds.
Cow peas	9	
Corn meal	10	
Sweet potatoes	30	49
(2)		
Cow peas	8	
Wheat middlings	12	
Corn	21	41
(3)		
Corn	20	
Wheat middlings	40	60
(4)		
Rice meal (pure bran)	12	
Corn	22	
Skimmed milk (gravity)	37	71

Molasses may be fed to hogs, using it as a partial substitute for corn, or other carbonaceous concentrate.*

The sample rations given for the different varieties of animals, besides those used in Louisiana, have been arranged from bulletins of the North Carolina and Florida Stations.

---

*For information as to the raising of special food crops for hogs, see other bulletins of this Station.

LOW-GRADE SUGAR CANE MOLASSES—BLACKSTRAP.

There is, perhaps, no stock-feeding material that has aroused so much general interest amongst stock owners and feeders in this country as Louisiana low-grade molasses. Hitherto this residue of the sugar-making process seems to have been looked upon as too laxative in its effects for general use, when given in any considerable quantity, and has been usually limited to occasional administration in small quantities to animals for market or for exhibition purposes, and, in some parts of the world, to relieve torpidity of the bowels in cattle.

It seems to have been the tendency of writers on molasses, as a food for horses, especially, to commend great caution in the use of this material on account of "looseness" of the bowels, as well as a diuretic effect induced by the potassium salts which molasses contains. Ware, in his most excellent work on "Molasses Feeding," states: "Among the numerous precautionary measures to be taken in feeding molasses, mention must be made of avoiding the exceptional molasses which contains saline elements. The late Col. Joshua A. Nunn, Deputy Director General of the British Army Veterinary Department, quotes a Lieut. Bausil, of the French Army, as saying that "great care has to be taken, as the salts of potash contained in molasses act as purgatives and diuretics." And such seems to have been the general impression, and doubtless the experience, of a great many stock owners who periodically made use of molasses to their animals. Hence, apart from its use as a laxative for cattle, its administration was limited almost solely to that of a condiment to induce horses to consume larger quantities of other food materials, or, in case of convalescence from some debilitating illness, as a tonic, pleasant to the taste and easy of digestion and assimilation.

To the ordinary purchaser and user of molasses, all varieties may look alike, and discrimination never once thought of. But, as to composition and physiological effect, there is a marked difference between the product of the beet sugar factory and that of the cane sugar factory. And, so far as our judgment goes, it is here where the discrepancy has arisen, giving the impression that molasses, as such, and without regard to its source, is purgative and diuretic in action, and hence requires to be "administered with extreme caution."

SUGAR CANE—THE SOURCE OF OUR "BLACKSTRAP" MOLASSES.—Experiment Station, Audubon Park, New Orleans, La.

As illustrating the difference in chemical composition of the two varieties (cane and beet), we quote the following from a communication by Dr. Chas. A. Browne, Jr., late chemist of our Sugar Experiment Station, and who has had extensive experience in some of the best laboratories of both the United States and Germany:

	Cane Molasses (Blackstrap).	Beet Molasses.
Water	20.93	23.70
Cane sugar	30.75	46.70
Reducing sugars	29.67	0.60
Ash (salts)	8.85	13.20
Organic (non-sugar)	9.82	15.80

Dr. Browne adds: "The cane molasses, as compared with the beet, contains 25 per cent more of sugars. Another noteworthy fact is the excess of ash ingredients in the beet molasses. This is due to the presence of a large amount of potash salts, which exert a strong purgative action upon the animal."

It would seem that the somewhat general impression that molasses, from any source, is unduly laxative must have been based upon the effect produced by the by-product from the beet factory, and not sugar cane molasses, as there is abundant evidence in our own State of the harmless effect of blackstrap, so far as a purgative action is concerned. A very striking corroboration of this fact was given a few years ago on some extensive sugar estates in Fiji, where a large number of valuable work-horses were fed, along with some grain, as high as 30 pounds per head per day without any untoward effects. After a time, however, this large quantity was reduced to 15 pounds, not by reason of any ill effect beyond a slight tendency to fatten, but because it was considered too risky an experiment with so much valuable stock. Contrary to expectation, the molasses diet produced constipation, instead of being laxative, and a few pounds of bran had to be given daily to keep the bowels in order. The ration, containing the 15 pounds of molasses, had been in use, at the time the matter was reported, for nearly two years, with excellent results. It was fed daily to over 400 head of horses, averaging about 1,270 pounds.

The chief value of molasses as a food is its economic source of carbohydrates (sugar), some idea of which may be had from the following:

	Diffusion Molasses.	Mill Molasses.
Carbohydrates (sugars)	67.07	65.90

From the above it may be seen how rich this hitherto-considered waste material is in the carbohydrate nutrient, and when it is known that these sugars are almost, if not completely digestible, its enhanced value may still further be appreciated.

The custom of feeding molasses to the work stock on our large sugar estates has been adopted, in anything like systematic manner, only within the past few years. Previously, and when the price was extremely low, quantities of the material were run into large iron troughs, and the mules allowed free access to it; and, to some extent, this rather prodigal method still prevails. The true value of blackstrap as a foodstuff has become more apparent of late years, however, and as the question of feeding economically has become one of considerable moment to our planters, it is being used more as an ingredient of the "balanced ration," and, as a rule, mixed with other concentrates.

Being desirous of collecting data for the purpose of collation with reference to the feeding of low-grade molasses on our sugar estates, the writer sent to a number of the larger planters a blank containing questions bearing upon the subject with the view of obtaining information which might be valuable for future reference.

The following is a reproduction of the question blank:

"(1) Do you feed "blackstrap" to your workhorses or mules?

(2) To what number of mules do you feed molasses

(3) Do you feed the molasses as an ingredient of a mixed ration, or by itself, and in what way?

(4) What quantity, by weight, do you feed at one time, and how much, approximately, does each animal consume per day?

(5) What other concentrates (grains, meals, bran, etc.) do you feed with the molasses, and what varieties of hay, or other roughage?

(6) How many times per day do you feed your mules during the working season?

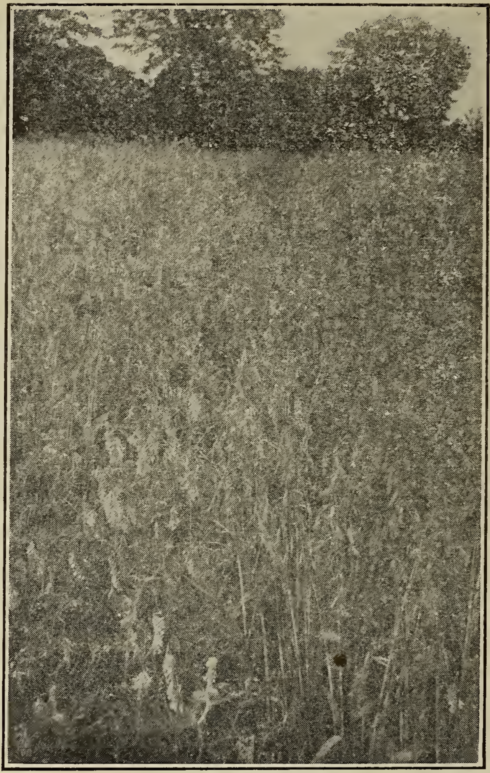
(7) What is the total amount in weight of the food given each animal per day, viz., concentrates? Roughage?

(8) Have you made any change in your system of feeding in the past five years, and if so, please state what the change has been?

(9) What is your observation as to the economy of feeding molasses?

(10) Since feeding molasses, and adopting a system more in keeping with the natural requirements of the animal, viz., a "balanced ration," what is your observation with regard to the health of your animals (dietetic ailments): their capacity for work, general condition, etc.?

SUPPLEMENTARY REMARKS."



OATS AND VETCH.—Experiment Station, Baton Rouge, La.

In summarizing, we may state that the replies represented what was being done in the matter of feeding blackstrap molasses on forty-seven estates in the sugar belt of the State. Some planters thought that molasses had "no nutritive value, but that it merely enticed the animals to consume more of other materials with which it might be mixed, by rendering them more palatable." Still others thought that it was not of sufficient "solidity" upon which to expect the animals to perform hard work, and should, therefore, under such conditions, be replaced to some extent by a more solid and bulky food. Some fed molasses as an ingredient of a mixed ration; others, by itself, ad libitum, in an open receptacle; while still others adopted both methods.

Quite a few knew the exact amount each animal consumed per day, as well as the other ingredients of the mixed ration, and could, therefore, make a close computation as to the cost of feed, while a considerable number made guess work of it, and had no accurate conception of the amount utilized by the stock. Some fed molasses to all of the different varieties of domestic animals on their places except chickens.

The fewer number of planters fed their animals three times per day; the majority twice.

The consumption of molasses per head per day, on forty-seven sugar estates, at the time the replies were sent in, averaged just about ten pounds, the range being from two to three pounds to a fraction over twenty-one pounds. The very great majority conceded to a considerable saving in the cost of the feed bills, ranging from 10 per cent to 50 per cent or more; and all seemed to refer to the marked diminution in the number of cases of dietic ailments, such as colic, etc., and the health, and, therefore, the capacity of the animals for work, being very much improved; all of which should certainly be taken into consideration when estimating results from the standpoint of economy.

There can be no reasonable doubt, we think, that the salutary results obtained from the feeding of molasses, exhibited in the improved condition of the animals and their freedom from indigestion, colic, etc., likewise the great reduction in the number of fatalities, is due to its almost perfect digestibility, and having to depend but little, if at all, on preparation before reaching the true digestive organs—the stomach and intestines.

As to the quantity of molasses fed to the animal, that should depend, of course, upon the carbohydrate constituents of the other materials, in order to have the digestible nutrients approximately balanced.

Being the cheapest source from which to obtain digestible carbohydrates, however, and being in such readily digestible form, it would seem economy to supply the sugar constituents of the food chiefly through molasses. But there is not any economy in giving an over-supply simply because it is cheap and the animal will eat it. Wolff, the great German, to whom we are so much indebted for information on animal nutrition, states that the addition of starch or sugar (they have the same chemical composition) to a diet of hay or straw, if it exceeds 10 per cent of the dry fodder, decreases its digestibility, particularly of the albuminoids (protein). Hence we are shown the necessity for foods being properly balanced in their digestible nutrients to prevent the depressing effect of a large amount of carbohydrates on the digestion of protein—the nitrogenous element of the food.

With the evidence before us, gathered from the experiences of a number of sugar planters who have now used molasses for several years, we cannot but claim for it a very high feeding value. But, by itself, it is not, of course, a perfect food, as it contains only one, we may say, of the important elements of nutrition. It is a valuable food for at least three good reasons: (1) It is the cheapest source we have, at present, at least, of the carbohydrate-nutrient, viz., sugar; (2) it is extremely rich in carbohydrates, containing in the case of mill (blackstrap) molasses about 65 per cent; (3) the complete digestibility (about 100 per cent) of its contained carbohydrates.

And we are of the opinion that the marked success which has attended its adoption is almost entirely due to the readiness with which it can be absorbed into the circulation of the animal.

On two or three of the plantations the mules were given green cane tops as roughage. With regard to this, we will quote the ration (including green cane tops) so successfully fed on the Fiji sugar estates, previously referred to, and allow the feeder to use his own judgment in the matter:

	Pounds.
"Molasses	15
Wheat bran	3
Corn	4

Cane tops—as much as the animals could eat. The molasses was mixed with the bran and chopped cane tops."

This per diem ration, as before stated, was fed to horses averaging 1,270 pounds in weight. The following is its composition per day and per 1,000 pounds live weight:

	Digestible Protein lbs.	Digestible Carbohydrates (including fat) lbs.
	1.13	13.31
Nutritive ration		1:11.8

The above ratio is much wider than the standard usually given for this class of animal, but, so far as the Fijian experience goes, the horses receiving this ration improved, both in health and in working condition.

Molasses being such a highly carbonaceous concentrated food, a roughage to feed with and balance it should be more or less highly nitrogenous. The majority of our sugar planters have two very valuable roughages of the latter class, viz., pea vine hay and alfalfa hay, both of them being what is termed complementary to the molasses, on account of their nitrogenous character. Our chief object in calling attention to this fact here is to suggest the importance of care in the production of these two crops, so as to secure them in the best possible condition to be used as a feeding material, as either of them, when damaged, not only loses in nutritive value, but becomes dangerous to the health of the stock. And besides, when not harvested at the proper time, is not nearly so nutritious, and, consequently, much reduced in value as a foodstuff.

The writer desires to acknowledge the valuable assistance rendered by Mr. Jas. E. Halligan, Chief Chemist, and Mr. J. G. Lee, Jr., of the Department of Animal Husbandry, of the Station. He also desires to acknowledge with thanks the drawing for the frontispiece by Mr. J. H. McCaleb, Jr., student, Engineering Department, L. S. U., '09.

La. Bulletin No. 116. June 1909.

Agricultural Experiment Station

OF THE

Louisiana State University and A. & M. College

BATON ROUGE.

PRELIMINARY REPORT

ON THE

ANTHRACNOSE OR POD SPOT DISEASE OF BEANS

By C. W. Edgerton.
Plant Pathologist.

BATON ROUGE
The New Advocate, Official Journal
1909

Louisiana State University and A. & M. College

Louisiana State Board of Agriculture and Immigration

EX-OFFICIO.

Governor JARED Y. SANDERS, *President.*
HENRY L. FUQUA, *Vice President of Board of Supervisors.*
CHAS. SCHULER, *Commissioner of Agriculture and Immigration.*
THOMAS D. BOYD, *President State University.*
W. R. DODSON, *Director Experiment Stations.*

MEMBERS.

R. S. Moore, Plaquemines.
Henry Gerac, Lafayette.
John T. Cole, Monroe.
John J. Henderson, Lagan.
J. E. Bullard, Belmont.
R. E. Thompson, Wilson.
Jeff D. Marks, Crowley.

STATION STAFF.

W. R. DODSON, A. B., B. S., Director, Baton Rouge.
HAMILTON P. AGEE, B. S., Assistant Director, Audubon Park, New Orleans.
J. B. GARRETT, B. S., Assistant Director, Calhoun.
S. E. McCLENDON, B. S., Assistant Director, Baton Rouge.
P. A. YODER, Ph. D., Chemist and Sugar Maker, Audubon Park, New Orleans.
W. G. TAGGART, B. S., Assistant Chemist, Audubon Park, New Orleans.
R. E. GRAHAM, B. S., Assistant Chemist, Audubon Park, New Orleans.
WM. G. OWEN, B. S., Bacteriologist, Audubon Park, New Orleans.
J. K. McHUGH, Secretary and Stenographer, Audubon Park, New Orleans.
G. D. HARRIS, M. S., M. A., Geologist, Baton Rouge.
J. E. HALLIGAN, B. S., Chemist, Baton Rouge.
H. L. GREEN, B. S., Assistant Chemist, Baton Rouge.
A. P. KERR, B. S., Assistant Chemist, Baton Rouge.
R. BAUS, B. S., Assistant Chemist, Baton Rouge.
R. G. FULLER, B. S., Assistant Chemist, Baton Rouge.
W. D. REID, B. S., Assistant Chemist, Baton Rouge.
R. G. TILLERY, B. S., Assistant Chemist, Baton Rouge.
S. W. PLAUCHE, B. S., Assistant Chemist, Baton Rouge.
ROGER P. SWIRE, Treasurer, Baton Rouge.
WILMON NEWELL, M. S., Entomologist, Baton Rouge.
G. L. TIEBOUT, B. S., Horticulturist, Baton Rouge.
W. H. DALRYMPLE, M. R. C. V. S., Veterinarian, Baton Rouge.
C. W. EDGERTON, Ph. D., Plant Pathologist, Baton Rouge.
J. T. TANNER, B. A., Secretary and Stenographer, Baton Rouge.
IVY WATSON, Farm Manager, Calhoun.
E. J. WATSON, Horticulturist, Calhoun.
J. G. LEE, Jr., B. S., in Charge of Feeding Experiments. Baton Rouge.
E. W. KERR, M. E., Professor Mechanical Engineering, Baton Rouge.
E. M. PERCY, B. S., Assistant Mechanical Engineer, Baton Rouge.
T. C. PAULSEN, B. S., M. D. C., Assistant Veterinarian and Bacteriologist.

PRELIMINARY REPORT

ON THE

Anthracnose or Pod Spot Disease of Beans.

By C. W. Edgerton.

The greatest drawback to the growing of beans in Louisiana is the trouble that is called ''spot,'' ''speck,'' ''anthracnose,'' or quite commonly, ''rust.'' The latter name, however, should not be used, as the term ''rust'' is more properly applied to another disease which sometimes attacks the leaves. Probably there is no one in the State that grows beans to any extent who is not familiar with the appearance of the ''pod spot'' trouble and who does not dread its appearance in his field. Quite often one hears in the trucking district the expression, ''I would grow more beans if I could keep them from spotting.'' Beans are a profitable crop when the disease is absent, but when it is present, the financial returns are very apt to be negative. Consequently it is not surprising to hear of the reluctance of the truckers to grow more of the crop.

The Experiment Station has been working on this trouble during the past two years, and it is believed that the control of the disease rests in the hands of the grower.

NATURE OF THE DISEASE.

To understand the method of control, it is necessary to understand the general nature of the disease. The disease is due to a very small organism which causes the decay of the bean substance. All understand that germs cause diseases in man and animals, but the fact that they also cause diseases in plants is not so generally understood. The organism that causes the spot on the bean pods is a very small plant, or fungus, as it is generally called, which can only be seen clearly by the use of a strong microscope. As higher plants reproduce themselves by seeds, this fungus reproduces itself by very small microscopic bodies which we call spores. These fall on the young bean pods and by growth cause the decay of the pod. The fungus uses the bean pod for food. After the fungus has been growing for a few days in the pod, it begins again to form the spores on the surface of the spot. Millions of these may be produced on a single bean pod in a few days' time. The slimy pink substance which is present in the spots is nothing but a mass of these spores. These spores carried to another pod produce again the spots. As these spores are imbedded in a gelatinous mass, they cannot be readily removed when the pods are dry. Hence we see the reason why we should not walk among or cultivate the beans while they are moist. There is a great danger of spreading the disease to all parts of the field.

The spores that are produced are not long lived, and are not normally able to live through the winter. For passing the winter the fungus has another method. If one will take the trouble to examine some ripe or nearly ripe bean pods that are badly spotted, he will very readily see the method of passing the winter. By breaking open the pod and examining the bean directly under the spot, he will often see that the bean itself has a spot on it. The fungus has entered the bean and in that condition it is able to pass the winter. A few of such affected beans are shown in Fig. 1. I examined during a trip to Pon-

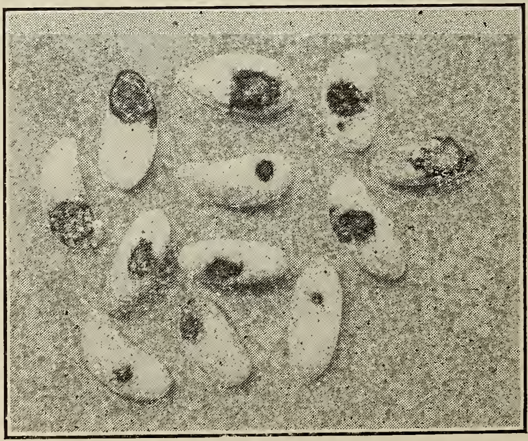


FIG. 1.—AFFECTED SEED OF DAVIS WHITE WAX BEANS. From such seed the "Pod Spot" disease is introduced into the field.

chatoula in the spring, a number of samples of beans that had been used for planting. I found in some cases as high as 10 per cent of the beans that were spotted in this manner. When these beans are planted, the fungus grows with the beans, and consequently we have the disease present in the field and ready to spot the beans if the weather conditions are suitable. Is it any wonder that with 10 per cent of the beans spotted, there were very few clean bean pods harvested?

With this brief description of the nature of the disease, we can see the reasons for the directions which are outlined for the control.

THE CONTROL OF THE DISEASE.

In the control of the disease there are two things to be taken into consideration. If you buy Northern grown seed, you are in most cases buying seeds which are more or less infected. In other words, you are introducing the disease in your field with each infected seed. In this case there can be nothing done other than to try to keep the disease from spreading from the diseased plants to the others. This is often difficult to do on account of weather and other conditions. Before planting time in 1909 a circular letter was sent out to a large number of truck growers in regard to the control of the trouble. Certain suggestions were made which we believed would be helpful in checking the spread of the disease. These suggestions were as follows:

1. Plant the beans if practicable so that the plants will not touch each other when grown. (We have found three beans to the hill and the hills eighteen inches apart very satisfactory.)

2. After the beans come up, stay out of the field until the cotyledons, or large, thick, seed leaves, drop off. This will only take a few days. This disease is carried through on these leaves, and on walking through the field the disease is liable to be carried from a diseased plant to healthy ones on the clothing.

3. After the cotyledons have fallen, the plants may be cultivated or hoed as desired, taking the following precautions: Do not enter the field when the plants are wet, either from dew or from rain. Only enter the field when the plants are perfectly dry. The germs of the diease are very sticky and are easily carried from plant to plant when moist. However, when they are dry, it is very difficult to rub them off from the diseased

plants. Do not by any means try to hoe or cultivate the plants while wet, as you are sure, if there is disease at all in the field, to carry it to all the plants.

4. Also in picking the beans, do so only when the plants are perfectly dry.

Some of the growers in the trucking districts tried to follow out the directions, and from a visit to some of the fields, I am convinced that they had less pod spot than they would otherwise have had. But some of them had used such badly infected seed to plant that it was out of the question to check the trouble. In order to give these suggestions a thorough trial, two plats planted with Wardell's Kidney Wax beans were laid out on the Experiment Station grounds, each of one-eighth of an acre. One plat was worked according to directions, and one was worked only in the early morning when the dew was heavy on the plants. None of the seed was affected, so to insure the presence of the disease in the plot, strips two feet wide running across the rows were inoculated with the disease. This inoculation was made when the plants were young, before they came in flower. The infected strips were twenty-five feet apart. When the pods were well formed, we had a very hard wind and rain which knocked the plants down and beat the pods into the ground. The conditions could not have been better for the spread of the disease. After this storm I expected the experiment to be a failure because the conditions were so exceptionally good for the disease. However, about two weeks after the storm, one row of each plot was gone over carefully, and the badly infected, slightly infected and clean beans in each row were counted. Each row represented about 1-120 of an acre. There were over 3,000 pods to the row. The row which was cultivated according to directions had 46.5 per cent of the pods spotted, while the row that was cultivated while the plants were wet had 55.3 per cent of the pods spotted. Or, in other words, there was a gain in clean pods in the plot cultivated according to the suggestions of 8.8 per cent. This would have meant twenty bushels of clean pods more to the acre. Under ordinary weather conditions this would probably have been doubled.

THE USE OF CLEAN SEED.

The second thing to be taken into consideration in the control of the disease is the use of seed from pods which were not spotted. If we have such seed to start with and take the precautions given in the suggestions above, there is no reason why there should be any of the anthracnose in the field. This has been demonstrated many times by Experiment Stations and bean growers. At the same time as the two plots described above were planted on the Experiment Station grounds at Baton Rouge, a third plot of the same size was planted with beans from the same lot, but the young plants were not inoculated with the disease. As this plot and the other two where the disease was present were not more than 100 yards apart, special care was taken to keep the disease from getting started in the plot. We tried to keep out of the plot as much as possible, especially after being in the infected beans. The following is a statement of the results:

While the two plots previously described had 46.5 and 55.3 per cent of the beans spotted, *not a single pod, spotted with the anthracnose,* was observed in this plot. Figures 2 and 3 show typical plants from this plot and from one of the other plots where the disease was present.

The solution of the trouble seems to rest on the question of obtaining the clean seed. Most of the seed bought from Northern growers is infected. It is impossible to pick over these seed and pick out the diseased ones, because some will always be overlooked. Furthermore, some of the germs of the disease which fall from the diseased seed to the healthy ones are still able to cause infection in the young plants.

Some have been trying Colorado grown seed with results more or less variable. While there is no doubt that the Colorado seed is freer from the disease than Michigan seed, it is still a question whether the best results are obtained from this seed. I have seen the anthracnose spots in various fields grown from Colorado seed. Whether the disease came in with the seed or whether it was introduced from a neighboring field is, of course, a question. However, during the past year, at least, the plants from Colorado seed have been much worse affected with the *blight,* another common disease of beans, than plants from other

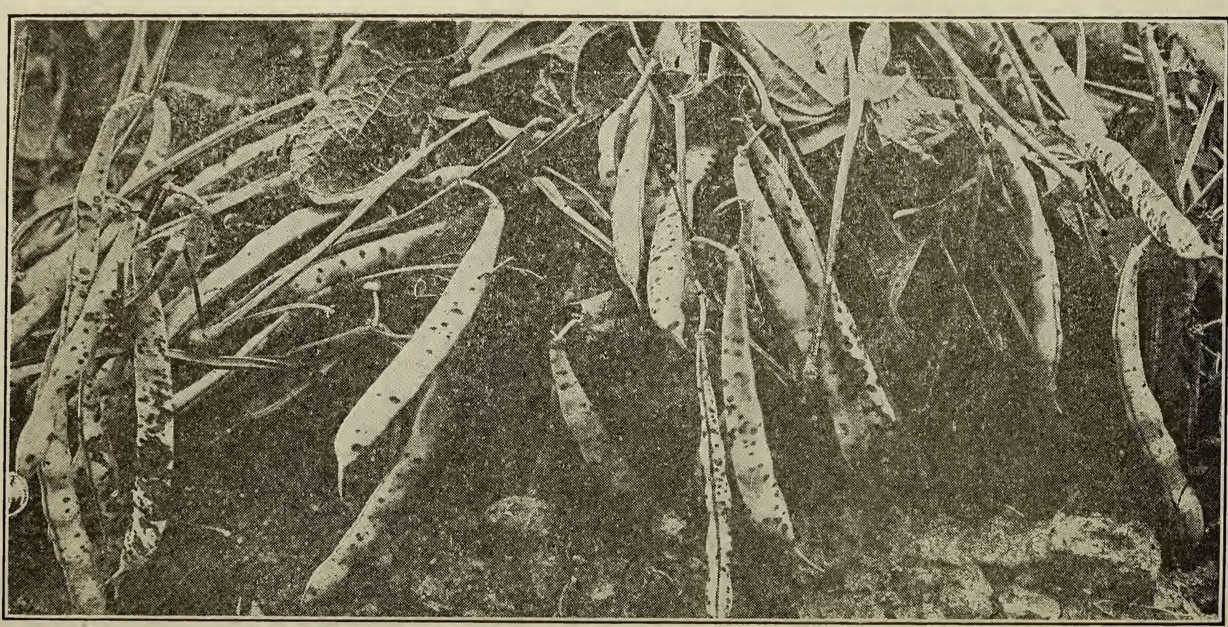


FIG. 2.—TYPICAL PLANTS WITH SPOTTED BEANS FROM A PLOT INFECTED WITH THE DISEASE.

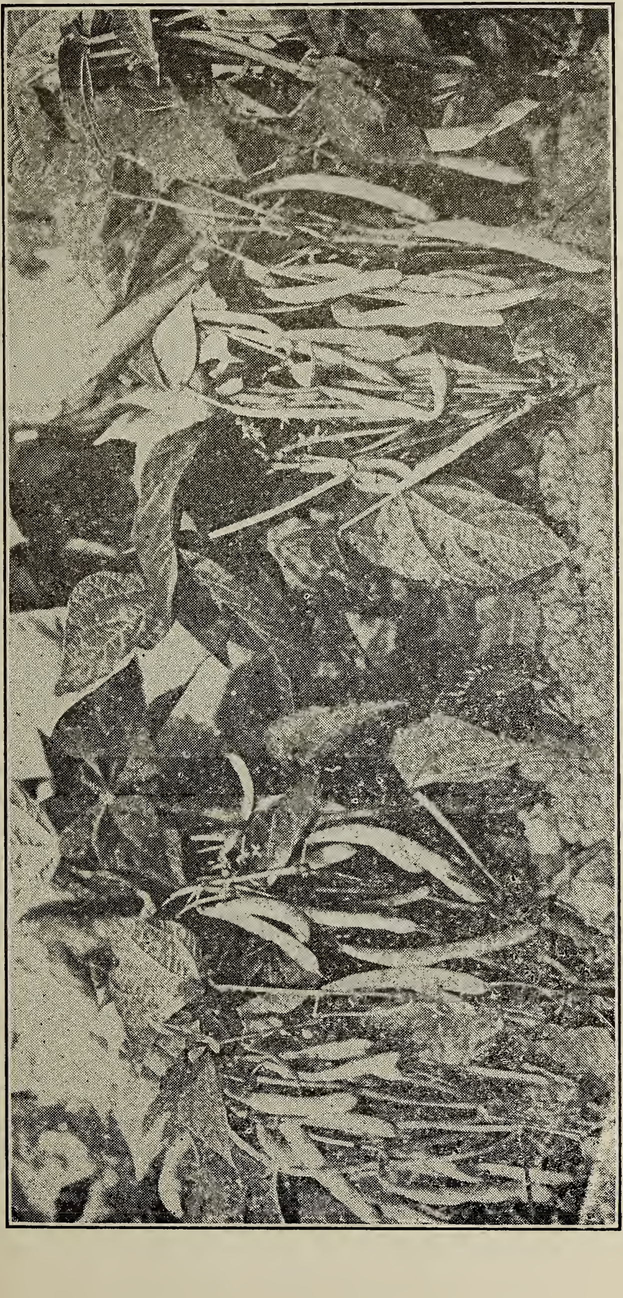


FIG. 3.—PLANTS WITH CLEAN PODS FROM A PLOT IN WHICH THERE WAS NOT A SINGLE SPOTTED BEAN.

seed. I noticed some fields at Ponchatoula in which a large per cent of the leaves had dried up and fallen from this disease. This is also a disease which is carried through on the seed. If this is generally the case with Colorado seed, it is questionable whether there is anything gained by its use.

The thing that we are advising is the use of home-grown seed. From a personal knowledge of the severity of the anthracnose disease in both the North and South, I am convinced that as a rule we have less of the disease in this section than further north. Yet we are buying these badly infected beans each year from the North for planting, and getting each year a new infection of the disease. A few experiments have been undertaken by the Experiment Station to test the practicability of using home grown seed as a method of controlling the disease, and they have been very successful. There are several factors in this region which normally tend to keep the trouble in check. These are primarily weather and soil conditions, but the discussion of these will be left for a future bulletin. We have found from the experiments that beans grown in the fall, even from diseased seed, are more or less free from the disease. The experiments are not as yet conclusive, but supplemented with the statements of several prominent truck growers that the fall grown crop is normally freer from the disease than the spring crop, they are worth taking into account. Test plots in the fall of 1908, both at Baton Rouge and Roseland, from seed containing a considerable quantity of disease, gave crops *absolutely free* from the disease. Some of the Roseland grown seed was planted at the Station grounds at Baton Rouge, and at the time of the writing of this bulletin, though we have had three weeks in which it has rained practically every day, there is not an anthracnose spot in the plot.

The object of this bulletin is to encourage truck growers to try planting some beans this fall for seed, the seed to be used next spring for planting the full crop. The planting can be made in July, or perhaps even early in August, and have the beans mature before a killing frost. The recommendations given above for the cultivation of the crop should be followed. We would be glad to hear from any of the growers who will try this, and also glad to get their results. From previous experiments and observations of various growers, it is probable that the fall crop will be entirely free from the trouble. However, if, as sometimes happens even in the fall, there is some spot on the beans, the healthy seed can be very readily saved at the time the beans are picked. If one discards all the pods that have spots on them, and only saves the clean pods for seed, the results will be the same. This will take a little more time, but when it may mean a saving of half the crop the succeeding year, it is surely worth doing. Now, in saving the seed, one should not confuse the anthracnose spots with some other spots which nearly always appear on ripening pods. These other spots are of no importance, and a pod should not be thrown out on account of their presence.

There is some prejudice against using home grown seed, but it seems to be unfounded. Beans grown at Roseland in 1908, planted at Baton Rouge along side Colorado grown seed of the same variety, are not in the least inferior. The plants are as vigorous and the beans are as early. Bulletin No. 68 of the Louisiana Experiment Station, describing four years' experiments with the use of home grown seed, has this to say: ''At Baton Rouge, nine times in four years the home seed fell behind (Northern grown seed), fifteen times it ran ahead, and in all other trials were equal. The results show plainly that when the seeds of bush beans are carefully selected and cured they will be the equal if not the superior of those grown in the North.''

SUMMARY.

Briefly, the methods for the control of the disease may be summed up as follows:

1. Grow the seed which is desired for planting the following spring in the fall.
2. If by chance there is some disease in the fall crop, select for seed only the healthy pods.
3. Follow the recommendations in regard to cultivation and picking which are outlined above, in order not to spread any disease which may accidentally get into the field.

NOTE.—During the fall or early winter, a bulletin will be published by the Experiment Station giving in detail the experiments which have been conducted on this disease. If any one desires this who is not already on the mailing list of the Station, it can be obtained at the time by writing to the Station.

Louisiana Bulletin No. 117. August, 1909.

Agricultural Experiment Stations

OF THE

Louisiana State University and A. & M. College

BATON ROUGE

AN EXPERIMENTAL STUDY

OF

BAGASSE AND BAGASSE FURNACES

E. W. Kerr, M. E.,
Professor of Mechanical Engineering, Louisiana State University,

ASSISTED BY

E. M. Percy, B. S.

BATON ROUGE
The New Advocate, Official Journal
1909

AGRIC. ECON. LIBRARY
LOUISIANA STATE UNIVERSITY

AGRIC.
LOUISIANA STATE UNIVERSITY

Baton Rouge, La., Aug. 31, 1909.

The Agricultural Experiment Stations, supported by the Hatch and Adams funds of the national government, have not devoted very much attention to problems of mechanical engineering. The work upon which the following bulletin is based invades practically a new field, and the following preliminary statement is deemed advisory.

In the instruction given in the course in sugar engineering of the University, Professor E. W. Kerr, Professor of Mechanical Engineering, was unable to obtain accurate data upon many of the specific problems that were to be considered in the course of instruction. Accordingly he made arrangements for carrying on some preliminary investigations regarding the operation of sugar house machinery, to secure data for the use of his students. We found that some of this data was of very great interest to the sugar planters of the State, and arrangements were made with Professor Kerr for the publication of Bulletin No. 107, "Preliminary Tests of Sugar House Machinery." This bulletin was received very kindly by the sugar planters, and we were encouraged to push the work further.

The question of the use of bagasse as fuel seemed to be one of the problems that called for investigation and arrangements were made with Professor Kerr to take up this work. We soon found that it was necessary to have an assistant, and Mr. E. M. Percy, a graduate of the Sugar Engineering course of the University (class of 1908), was employed to assist in securing the data given in the following pages. Mr. Percy has taken great interest in the work and has been untiring in his efforts to contribute to its efficiency and completeness.

The producer of cane is generally a manufacturer of sugar, and, as there are no public institutions making research along mechanical lines effecting problems of the cane sugar house, it has been decided to establish a Mechanical Department of the Experiment Stations, and arrangements have been made by which Professor Kerr will give one-half of his time in the future to the work of the Experiment Stations in the solution of engineering problems of the sugar houses. This work will be conducted under the provisions of the Adams Act of the National Congress, so that we may confidently expect the continuation of the work until the more urgent problems have been given attention.

Very respectfully,
W. R. Dodson,
Dean and Director.

INTRODUCTION

During the last few years the writer, who has charge of the instruction of students in the engineering branches of the Audubon Sugar School, has visited a large number of sugar factories in Louisiana for the purpose of gathering data and information for classroom use. In these visits he has been particularly struck with the lack of uniformity in the methods employed for utilizing bagasse as a fuel both as to the form and proportions as well as the manipulation of the furnaces. No less striking is the variation in the quantity of extra fuel oil required per ton of cane in the different houses. A house of 1000 tons capacity per 24 hours requires, for economical operation, at least 1500 boiler horse power. A well designed house in Louisiana will generate two-thirds to three-fourths of this power with bagasse alone, though the average house does not utilize its bagasse so well, and the fuel oil bills run correspondingly high. The oil consumption varies from about five gallons per ton of cane to twenty or more gallons, depending mainly upon the arrangement and size of the plant, also the kind of product manufactured. Taking a 1,000 ton plant as a unit this means a total of say $7500 for oil per season in the most economical plants, in the neighborhood of $25,000 for the plants operating under the most unfavorable conditions, and probably fifteen to twenty thousand dollars in the average house. These figures, though approximate, indicate the importance of the question.

It must not be forgotten, however, that the bagasse furnace is only one of a great number of parts of a sugar factory, the improper design or operation of which may result in excessive oil consumption. As instances of conditions other than those in the bagasse furnace leading to excessive heat losses, we may mention boilers of poor design or which by lack of care have accumulated soot or incrustations upon their heating surface; long lines of poorly arranged and uncovered steam piping; failure to provide fully for the utilization of the heat in the exhaust coming from the engines of the house; absence of feed water heaters; failure to use all of the water of condensation from steam piping, evaporators, pans, etc.; the use of mill and other engines extravagant in the use of steam; evaporation in open vessels. Many houses on account of having been built up from relatively small beginnings, have a large number of small pumps and engines. In other words, there is a large number of small steam cylinders where a smaller number of large steam ones might have been used. It is a well known fact that there is proportionately much larger loss of steam by condensation in small cylinders than in larger ones. As examples of extreme conditions in this respect, the writer knows of two very large factories, one of which had 40 steam cylinders per 1000 tons capacity and the other less than six cylinders for the same unit of capacity. The steam consumption is also affected by the system of clarification used, the open pan clarifiers consuming more steam than those using closed heaters, on account of the greater loss by radiation.

Another source of considerable steam loss is caused in some factories where the juice is boiled after clarification in open pans before passing to the effects. The steam consumption is affected by the nature of the final products of manufacture. These vary considerably, the practice in Louisiana tending toward more reboiling than in the tropics. Some of the houses make first, second and third sugars which results in an excessive consumption of steam on account of the three boilings and the increased amount of centrifugal work. Other factories produce only a first sugar and a salable molasses which reduces the steam consumption materially by avoiding two boilings and two centrifugalings. The boiling of the strike of a ten foot pan requires from 25,000 to 50,000 pounds of steam, depending upon the nature of the product boiled and the duration of the boiling. Maceration increases the fuel consumption because it increases the amount of steam required to evaporate the greater quantity of juice and because with the greater resulting extraction, the fuel value of the bagasse is lowered.

It is rather common to attribute the fuel losses in a plant to the bagasse alone, when in fact, the trouble is often to be found in poorly arranged and poorly operated oil burning furnaces. The writer is inclined to believe that this is a source of great unnecessary fuel consumption and deserves equal consideration with bagasse burning. Of course the size of a plant has much to do with the steam consumption and therefore the quantity of fuel oil per ton of cane ground, the smaller the plant the greater the consumption. This is principally due to the fact that the losses of steam condensation are greater in smaller houses which have, as a rule, smaller steam pipes, steam cylinders, etc. The condensation in a pipe, other things being equal, is proportional to its radiating surface—that is, its circumference, while its capacity for carrying steam is proportional to the internal cross-sectional area. The ratio of the circumference to the area is greater for small than for large pipes—for instance, in a 2'' pipe the circumference and area are respectively 6.28 and 3.14, the ratio being $\frac{6.28}{6.14} = 2$ while for an 8'' pipe we would have a ratio of $\frac{25.13}{50.26} = .5$ about. The reasons for increased condensation in small cylinders are essentially the same as those just given for small steam pipes. In view of the different conditions named above, prevailing in different houses and affecting the steam consumption, it is evident that ''gallons of oil per ton of cane'' cannot serve as a unit with which to measure the efficiency of bagasse furnaces, but rather that of the whole plant. A sugar house might have the very best and most efficient bagasse burners together with a poorly arranged or small house and have an oil consumption of twelve gallons of oil per ton of cane. On the other hand, a poor bagasse burner in an otherwise well planned house, especially if it were a large one, might give an oil consumption of five or six gallons of oil per ton of cane. However, even though the combinations named above are possible and really exist in numerous houses, it should not be concluded that the furnace can be neglected. On the other hand, very little reflection will convince us that it is the most important part, as far as fuel economy is concerned, of the plant as regards both design and operation, especially the latter. Once a steam engine is installed in a plant, there is little the operator can do that will affect the economy, no matter how much that economy might have been affected by the design. In the case of the boiler and furnace, however, we have that the efficiency depends not only upon the original design but more upon the manner in which it is operated, the skill of the fireman being the controlling factor.

OBJECTS OF THE INVESTIGATIONS.

In view of the above points of consideration it was decided to conduct a series of investigations the object of which should be to gain a thorough insight, by general observation and by tests, into the methods used in Louisiana for utilizing the heat from bagasse. After the completion of the investigations in the Louisiana houses it was decided to extend the work to Cuba also. It will be evident upon consideration that investigations with the objects stated above must be such as will eliminate from consideration everything excepting the fuel and the furnace. The general method of judging as to the performance of a boiler and furnace is, what is known as, the *evaporative test* the main objective of which is pounds of water evaporated from and at 212 deg. per pound of fuel. This method of testing, however, can only be used in determining the efficiency of the boiler plant as a whole, the results of the test depending as much if not more upon the boiler as upon the furnace. It was therefore decided to formulate some method of testing that would give definite information as to the conditions existing in the furnace, eliminating the boiler, as far as possible. In order to make as clear as possible the reasons for determining upon the line of investigations subsequently pursued and which are fully described later, some of the main principles involved in boiler operation will be discussed.

BOILER PLANTS IN GENERAL.

Explanation of Principles.—Before taking up the discussion of the subject proper, a few terms that will be used frequently in the following pages will be explained briefly.

Temperatures will be referred to in terms of degrees Fahrenheit. According to modern theory heat in any substance, whether that substance be solid, liquid or gaseous, accompanies a vibration of its molecules, and the intensity of this molecular vibration is measured in temperature, the English unit for which is the degree Fahrenheit. It should be clearly understood that temperature is not a measure of the quantity but rather of the intensity of heat. As an example let us consider two cubes of hot iron, one weighing 20 pounds and the other 40 pounds. Their temperatures may be exactly equal and yet the quantity of heat in them will not be the same. The unit of measurement of heat is the British Thermal Unit (B. T. U.), which is the quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit. Since it takes different amounts of heat to make this change at different elevations of temperature a more exact definition of a B. T. U. is the heat required to raise one

Specific heat is the capacity a substance has for heat or in more exact terms, it is the number of British Thermal Units required to change the temperature of the substance one degree Fahrenheit. The specific heat differs for different substances, that for pure water being taken as a unity. To determine the number of B. T. U. required to change the temperature of a pound of a given substance, through a given number of degrees temperature we multiply the change of temperature in degrees by the specific heat. Take as an example, the two cubes of iron mentioned above. The specific heat of iron, as found in tables, is .12. Suppose the temperature of the 20 lb. cube to be 200 deg. and its final temperature 300 deg. The change in temperature is 100 deg. and the B. T. U. required to make the change is 100x.12=12 and for 20 pounds 12x20=240 B. T. U. It is evident that it will require exactly twice this amount to raise the temperature of the 40 lb. cube the same amount. If there had been 20 lbs. of water instead of iron the heat required to change the temperature 100 deg. would have been 100x1x20=2000 B. T. U., the specific heat of water being unity.

An important application of the above principles is found in the conversion of water into steam. If heat is added to a pound of water at 32 deg. its temperature rises until the boiling temperature is reached, the B. T. U. required to do this being equal to the boiling temperature minus 32 deg. multiplied by the specific heat which may for all practical purposes be taken as 1. This boiling temperature is 212 deg. provided the water is in an open vessel—that is, under atmospheric pressure, which is 14.7 lbs. approximately. For other pressures, however, the boiling temperature varies. For instance, it is 337 deg. in a boiler at 100 lbs. gauge pressure and 126 deg. in the second body of a double effect working with a vacuum of 26 inches of mercury corresponding to a pressure of about 2 lbs. per square inch. The boiling temperature for different pressures may be found in the steam tables provided in text-books, also in many of the trade catalogues of boiler and pump manufacturers.

Returning again to the pound of water, after heat sufficient to raise it to the boiling point has been added, further addition of heat causes evaporation to commence, the temperature remaining constant until the entire pound has been evaporated. The heat added during this change, at constant temperature, is called "latent heat" or "heat of evaporation." The heat required for the complete change from 32 deg. to dry steam at the boiling point is called "total heat." Both the latent heat and the total heat for different pressures may be found in the steam tables.

For example: Let us calculate the heat required to convert a pound of water at 60 deg. F. into dry steam at 100 lbs. gauge. Adding 14.7 we have an absolute pressure of 100+14.7=114.7 lbs Referring to the steam tables we find that the temperature corresponding to this pressure (which means boiling temperature) is 337 deg., and that the latent heat is 876. The heat required to raise the temperature of the water to the boiling temperature is 1×(337—60)=277 B. T. U. Adding to this the heat required to evaporate the pound we have 277+876=1153 as the B. T. U. required to convert one pound of water from a temperature of 60 deg. into dry steam at 100 lbs. gauge.

Dry or saturated steam is that which has no moisture in it or in other words, is saturated with heat. Wet steam on the other hand has moisture in it which has not been evaporated. Steam of 95 per cent quality means that 5 per cent of the moisture has not been vaporized. If in the above problem we substitute "95 per cent dry" for "dry" the total heat required will be 277+876×.95=1109 B. T. U. per pound. If after the pound of water has been completely vaporized, we add more heat, the temperature will rise above that shown in the steam tables which deal only with dry steam. Steam with the temperature thus increased is called "superheated steam." The heat in B. T. U. required to superheat is obtained by multiplying the number of degrees of superheat by the specific heat of superheated steam which may be taken as .5. For example, let the above problem be changed to read, find the B. T. U. required to change one pound of water from a temperature of 60 deg. F. into steam at a pressure of 100 lbs. gauge and a temperature of 437 deg. F. The total heat required will be 277+876+.5(437—337)=1203 B. T. U. Only a step further is required to exhibit the method of determining the value of a boiler H. P. According to the A. S. M. E. Standard, this is the evaporation, in one hour, of 34 1-2 pounds of water from a feed water temperature of 212 deg. into dry steam at 212 deg. (usually designated as "from and at 212 deg."). The heat required to effect this change is evidently the latent heat at 212 deg. which, from the steam tables, is 965.8. The heat value of a H. P. in B. T. U. is therefore 965.8×34.5=33320 per hour. For example, suppose a boiler to evaporate 3000 pounds of water per hour from a feed water temperature of 60 deg. into dry steam at a perssure of 100 lbs. gauge. The total B. T. U. supplied to it per hour will be (see first example above) 1153×3000=3459000 and the horse power will be $\frac{3459000}{33320}=103.8$. If this boiler had converted the same weight of water into steam 95 per cent dry the H. P. would have been $\frac{1109\text{x}3000}{33320}=99.3$. If the same weight had been converted into steam at a pressure of 100 lbs. gauge and temperature of 437 deg. the H. P. would have been $\frac{1203\text{x}3000}{33320}=108.3$.

ANALYSIS OF THE PROCESSES IN A BOILER PLANT.

The processes of a boiler plant may be divided into two general parts, the generation of heat and the transferrence of the heat to the water. Of these, the first is of greatest importance and is most difficult to obtain efficiently. In carrying out this part of the operation, a fuel must be burned, the quantity of heat per pound and the size of the grate, depending upon the heat value and density of the fuel. The net heat value of the fuel depends upon the quantity of moisture and ash in it. To burn any fuel oxygen must be supplied and in order to get the entire heat value enough oxygen must be supplied for complete oxidation. This means that arrangements must be made for a supply of air with pressure great enough to insure intimate mixture of air and fuel. At the same time the air supply should not be so great as to unnecessarily cool the furnace and fire. As the heat of the fire drives off gases some of which are not burned at the grate, that part of the furnace back of the grate must be of such form as will facilitate the further complete burning of these gases. To carry out the second part of the process, viz that of the transferrence of the heat generated to the water, it is necessary first of all, to so confine the heat generated that it can not pass away until after it has remained in contact with the heating surface a sufficient time for its absorption. The flow of heat from one body to another depends upon the difference in temperature of the two bodies, the flow being always from the body of higher temperature to the body of lower temperature. It is evident therefore that this flow of heat from the gases through the metal walls of the boiler to the water will be greatest when there is a maximum of difference between the temperature of the furnace and of the water in the boiler which difference is produced with a maximum furnace temperature and minimum water temperature. The rate of flow of heat per unit area through the heating surface is also dependent upon the cleanness of the metal walls and it is therefore important to keep the inside and outside of same free from soot and scale. Finally, since one square foot of heating surface can transmit only a certain number of heat units per degree of difference of temperature per hour it is evident that the heat generated should not be so great that only part of it can be absorbed—that is, the amount of heating surface should be properly proportioned with the fuel burning part of the plant. The most efficient transferrence of heat from gases to water will of course result in the greatest lowering of the temperature of the gases and this means that a low smokestack temperature indicates efficient work.

FUELS AND COMBUSTION.

The principal heat producing elements of fuels are carbon and hydrogen which exist in different proportions with oxygen in different fuels. Of these, carbon is the more important, the quantity of this element existing in a fuel largely determining its value. In addition to the elements named above, all fuels contain more or less moisture, other organic substances also incombustible elements which produce ash. Fuels may also be classified according to the amount of volatile matter, in the form of hydrocarbons, driven from them during combusion. In general it may be said that solid fuels rich in carbon have little volatile matter and that those poor in carbon have much volatile matter. As an example of the former, we have anthracite coal, and of the latter, bituminous coal or lignite, wood, etc. Fuels rich in carbon usually burn with little flame, while those ric in volatile matter burn with much flame. The fuels with large bulk, such as wood, tan bark, straw, bagasse, etc., all produce much flame. In general it may be said that the existence of much flame is an indication of low heat value.

Bagasse, as it comes from the cane mill, consists of water, woody fiber (cellulose), sucrose, glucose and other solids in varying proportions, depending upon the quality of the cane crushed, as well as upon its treatment in the mill. The amount of moisture depends upon the number of crushings and the pressure applied in crushing, varying approximately from 40 to 56 per cent. The quantity of sugar in the bagasse (extraction), depends, in addition to the above, upon the maceration, the more thorough this being done the less sugar there is in solution in the moisture contained in the bagasse. The extraction in Louisiana varies roughly between 70 and 80 per cent, the probable average being about 78 per cent. In Louisiana the fiber in the cane which furnishes the larger part of the heat for combustion is about 10 per cent of the weight of the cane. This small value is due to the fact that the cane must be cut before maturity on account of early frosts. In the tropics, however, where the cane may be allowed to grow to maturity,the fiber is greater,being from 12 to 20 per cent, though 12 per cent is probably a fair average. Columns 1-4 in Table A show the composition of unmacerated bagasse with different extractions, the first resulting from cane with 10 per cent fiber as found in Louisiana, and the second for cane with 12 per cent fiber, as found in the tropics.

The sum of the sugars, non-sugars and fiber is called "total solids." As stated above fiber is cellulose, a compound composed of carbon, hydrogen and oxygen, its formula being $C_6H_{10}O_5$ with atomic weights of 12, 1 and 16 respectively, and a molecular weight therefore of $6\times12+10\times1+5\times16=162$. Hence the per-cent carbon is $100\ \frac{72}{162}=44.4$. In the same manner the percentage of hydrogen is found to be 6.17 and that of oxygen 49.38. The following formula for sucrose, another fuel constituent of bagasse is $C_{12}H_{22}O_{11}$, and a calculation similar to that just made for cellulose shows 42.1 per cent carbon, 6.43 per cent hydrogen and 51.46 per cent oxygen. It should be noted that in the formulas for both cellulose and sugar, the hydrogen and oxygen exist in the proportions (two of hydrogen and one of oxygen) to form water upon combustion, but as will be explained later, without formation of heat. Returning to the carbon in the bagasse, let us consider a sample of bagasse resulting from a 75 per cent extraction from cane of 10 per cent fiber as found in the above table (A). This bagasse consists of 51 per cent water, 40 per cent cellulose and 9 per cent sugars and non-sugars. Using the percentages of carbon deduced above and neglecting the small amount of non-sugars, we have $.40 \times .444 + .09 \times .421 = .2146 = 21.46$ per cent carbon as based on the wet bagasse. This shows the small percentage of carbon in a pound of wet bagasse.

Table A is calculated for unmacerated mill bagasse only, the items being computed on the assumption that cane consists of water, fiber and sugar, only, and that the juice in the bagasse has the same composition as that extracted. Summarizing, one pound of the bagasse will contain approximately:

Free moisture	51.0%
Moisture of formation, from sugar, 55.6×40	22.0%
Moisture of formation, from sugar, 67.9×9	6.0%
Total moisture	79.0%
Carbon from fiber	17.7%
Carbon from sugar	3.8%
Carbon total	21.5%

COMBUSTION.

Combustion is a process of oxidation and this oxidation or act of combining with oxygen is accompanied by the liberation of heat, the intensity of which is proportional to the rapidity of oxidation. The quantity of heat liberated by a piece of iron taking months to oxidize (rust) is the same as that which would have been liberated during combustion at white heat in a few moments. Carbon and oxygen may combine in the proportions one atom of carbon to one atom of oxygen to form carbon monoxide CO, evolving 4600 B. T. U. per pound of carbon. This combination is due to incomplete combustion on account of lack of oxygen.

Carbon also combines with oxygen in the proportions of one atom of carbon to two atoms of oxygen to form carbon carbon dioxide, CO_2, provided there is a sufficient supply of oxygen. In this case 14600 B. T. U. are produced per pound of carbon and the combustion is said to be complete.

Hydrogen combines with oxygen in the proportions of two atoms of hydrogen to one atom of oxygen to form water, H_2O, evolving 62000 B. T. U. per pound of hydrogen, provided the water of formation is cooled to 32 deg. Fahrenheit.

Marsh gas or Methane, CH_4, combines with oxygen to form H_2O+CO_2 and in doing so evolves 23513 B. T. U. per pound. This gas is the principal of the many hydrogen carbons, known as volatile gases, driven off from fuels when first coming in contact with the fire. The heat values named above have been determined experimentally by burning known quantities of the substances and measuring their effect, generally in raising the temperature of a known quantity of water. It will be noticed, however, that, so far, we have considered, mainly, the heat value of single elements. Most fuels contain several elements and to determine their heat value we must determine the heat due to their combination during combustion. This may be done experimentally by burning a known weight of it in a calorimeter as explained above for single elements or by determining the quantity of each of the constituent elements by a chemical analysis, from which the heat value may be calculated by the use of formulas. The first method named is the better but requires costly instruments. The second is fairly accurate and can be done in a chemical laboratory. The formula generally used for the latter is $Q=14600C+62000(H-\frac{O}{8})$ in which Q is the heat value in B. T. U. of one pound of the fuel analyzed. This formula is due to Dulong and is based upon the assumption that the heat generated by a fuel during combustion is equal to the sum of the possible heats generated by its component elements, less that portion of the hydrogen which might form water with oxygen of the fuel. C, H and O represent the proportions of carbon, hydrogen and oxygen in a pound of the fuel. For example, a coal giving a chemical analysis of 60 per cent carbon, 5 per cent hydrogen and 10 per cent oxygen would have, according to the above formula, a heat value of $Q=14600\times.6+62000(.05-\frac{.1}{8})=11088.7$ B. T. U. Using the analysis of dry bagasse, given on page 11 of 44.4 per cent carbon, 6.17 hydrogen and 49.38 oxygen we find by Dulong's formula that the theoretical heat value of a pound of cellulose is $14600\times.444+62000(0.0617-\frac{.4938}{8})=6482$ B. T. U.

A similar calculation for sugar, the analysis of which is also found on page 12 gives a value of 6126.6 B. T. U. It should be noticed in the above calculation for cellulose that the quantity in the parenthesis is zero which means that the oxygen and hydrogen in the fuel are in the proportions to form water so that the carbon only, produces heat. The same thing would hold also for sugar. In a paper read several years ago before the British Institution of Civil Engineers by Stahlman and Langbein it was stated that they had found, by calorimeter tests, that cellulose gave a heat value of 7533 B. T. U. per pound, also that sucrose and glucose gave 7120 B. T. U. and 6748 B. T. U. respectively. In order to show the manner of calculating the heat value of bagasse, using this data, let us assume a sample with the following composition: water 42.8 per cent, fiber 50 per cent, sucrose 6 per cent, glucose 0.25 per cent and other organic matter 1.25 per cent. Assuming that the organic matter has the same heat value as the fiber, the gross heat value of one pound of bagasse would be $.5\times7533+.06\times7120+.0025\times6748+.0125\times7533=4307.7$ B. T. U.

It should be thoroughly understood, however, that a portion of this heat is consumed in converting the 42.8 per cent water into steam and raising its temperature to that of the stack. Assume that the temperature of the bagasse as it reaches the furnace is 70 deg. F. and that the stack temperature is 500 deg. F. The heat required to convert the moisture into steam at 14.7 lbs. (the pressure in the furnace) is $(212-70+965.8)0.428=454.13$ and that for superheating is $0.5\ (500-212)=144$, making a total of $454.13+144=598.13$ B. T. U. Subtracting this from the gross thermal value we have $4307.7-598.13=3709.6$ B. T. U. as the net thermal value of a pound of the bagasse under consideration. If it is possible the heat value can be better determined by burning a sample of the bagasse itself in a calorimeter. A number of such determinations have been made, the results in most cases being considerably higher than the calculated values.

Calorimeter tests of dry bagasse from sixteen different mills, made by the author, gave an average of 8375 B. T. U. per pound of dry matter. Taking the bagasse just calculated, there is a total of $0.50+0.06+0.0025=0.5625$ pounds of dry matter. The heat value of the wet bagasse would therefore be $8375\times0.5625=4711$ B. T. U. and the calculated value is $\frac{4711-4307}{4711}\times100=8.5$ per cent less than the calorimeter value. The values in column 5 of table A were calculated on a basis of 8375 B. T. U. per pound of dry matter in bagasse. The above discussion and calculations have been based upon complete combustion, otherwise the values would be lower.

FURNACE CONDITIONS FOR COMPLETE COMBUSTION.

If the conditions in the furnace are not proper the carbon, as stated before, may burn to CO instead of CO_2 causing a loss of about two-thirds the possible heat value; or some of the hydrogen or hydrocarbons may pass away unburned. It will now be in order to discuss some of the conditions necessary for the complete combustion of fuels in furnaces, other things being equal that furnace being most efficient which burns its fuel most completely. Since the incomplete combustion or burning to CO is due to scanty air supply it is necessary to supply a sufficient quantity of air to the burning fuel, thereby producing CO_2. This may be done by means of a chimney alone, by means of mechanical draft or by a combination of mechanical draft and natural draft. Mechanical draft may be of two kinds, viz: forced draft and induced draft. Forced draft is effected by supplying air under pressure to the furnace either through hollow blast grate bars or to the ash pit from whence it flows upward through ordinary grate bars and the fuel. The air pressure in the case of forced draft may be supplied by means of a rotary fan or blower or by means of a steam jet blower, the former being most commonly used. Induced draft is that in which a suction or vacuum is produced in the furnace by placing a fan or steam jet between the furnace and the base of the smokestack and thus inducing the flow of the product of combustion toward and past the blower or jet. In most sugar houses a combination of natural and forced draft is used, though in a few houses natural draft is found. Forced draft cannot be used alone by reason of the fact tat the hopper must remain open at least a part of the time and issue from this and other openings.

In order to bring out the essentials in boiler furnace combustion let us first consider briefly the fuel and furnace with which we are most familiar, the proper design and operation of which has een most firmly established by the experience and experimental investigations of a long term of years, that of coal. Let us suppose that the fire is burning on an ordinary grate with coal as the fuel and that normal conditions obtain. The bed of coals and fire is of moderate thickness and the fire burning well, the carbon of the fuel combines with the oxygen of the air to form CO_2 ($C+2O=CO_2$) which is a gas rises and passes through to the stack. If, however, the fuel bed is quite thick a different set of conditions exist. In this case that part of the fuel nearest the grates is in the form of hot coals and that at the top greener fuel. The combustion is therefore more perfect at the bottom than at the top and with a sufficient air supply the carbon combines with the oxygen of the air and CO_2 is formed as before. This CO_2 at a high temperature then has to pass upward through the layer of greener fuel above where it combines with more carbon to form CO, ($C+CO_2=2CO$). This is what would happen if there is not an excess of air. By having an excess of air enough uncombined oxygen passes through the interstices of the fuel to combine with the CO above the fuel to produce CO_2, ($2O+2CO=2CO_2$).

This same combination is also sought by admitting air through openings in the fire door which supplies the oxygen for burning the CO to CO_2. For the same purpose, air is often admitted through holes in the bridge wall or through the sides of the furnace. At the same time hydrogen and the volatile hydrocarbons such as marsh gas, etc., are driven off from fresh charges of the fuel and a supply of oxygen above the fuel is needed for their cumbustion so that the air admitted through the fire doors, bridge wall, etc., serve this purpose also. From the above it is seen that a thick fuel bed is conducive to the formation of CO and therefore of loss due to incomplete combustion.

This effect is also produced by throwing fuel on the fire without spreading it evenly on the grate. In general it may be said that the thickness of the fire should be only thick enough to prevent the formation of holes through which air would pass.

AIR SUPPLY.

So far much has been said about the necessity for a sufficient air supply in order to insure complete combustion. On the other hand, too great a supply of air will result in great harm on account of the cooling effect upon the furnace. This cooling of the furnace is harmful both in reducing the temperature of the furnace below that of the igniting point of some of the products and in lessening the flow of heat from the boiler to the water, the flow being proportional to the difference in temperature. One of the most fruitful causes of air excess, in operation, is due to allowing the fire to burn through in spots so that air passes through unrestricted without coming in contact with carbon. Thin fires are not liked by firemen for the reason that they have to be watched too carefully to prevent the holes. Better results are evidently produced by supplying fresh charges at short intervals than by heavy charges over the entire grate. On the other hand, a thick fuel bed is a means of reducing the excess of air and with fuels that do not clinker or cake, better results are obtained with thick than with thin fires. Insufficient air supply may also be due to lack of draft. This in turn may be due to a chimney of insufficient height or diameter or both; also to restricted area of passages in the boiler setting or in the tubes. The following areas are very generally adopted:

	Bituminous.	Anthracite.
Area over bridge wall...............	1-5	1-7
Area through tubes	1-6	1-8
Area chimney flue	1-7	1-9

The fractions are in terms of the grate surface. It will be noticed that the areas for bituminous coal are greater than those for anthracite. This is because of the greater volume of gases produced by bituminous coal. For fuels with much moisture which is converted into large volumes of steam, in addition to the other products of combustion, the areas required are still larger. An insufficient air supply is also caused by a choking of the fire which may be due to failure to stir the fire, causing an accumulation of ashes or to a clinkering or caking fuel, the bad effects of which may be controlled more or less by the firemen.

As stated above, too much air ("air excess") may be due to holes in the fire, due to careless firing, which are most likely to form at the back of the grate. It may be due also to too much draft, caused by an excessively high chimney. It may be said, however, that a chimney taller than is necessary for normal conditions is a good asset as it is then possible to exercise control of the draft by means of a damper between the furnace and stack. In other words, it is easy to reduce the draft by means of a damper, but impossible to increase it. Another cause of air excess is that of leakage through the setting, due either to cracks or to the porous condition of the brick forming the furnace walls. The latter is a source of great leakage, though it can and should be prevented by painting the bricks. The air supply can be regu. lated also by manipulation of the draft doors, though it is better to do this by means of the stack damper for the following reason: draft is simply another word for vacuum. With chimney draft air flows into a furnace because the pressure in it is less than that of the atmosphere outside and the air rushes in to fill the void. The greater the opening at the front of the furnace the less this vacuum will be for the reason that there is more chance for equalization of the furnace and outside pressures. On the other hand, the smaller this opening the greater the vacuum. The result of closing the draft doors therefore is to increase the vacuum in the furnace and setting which means a greater leakage through the cracks and pores of the setting, over-balancing to a large extent the stoppage of the supply through the draft doors. Closing the damper in the stack, however, decreases the vacuum in the furnaces and in this way the inward flow of air, without the increased leakage through the setting which attends the closing of draft doors. It is therefore a much more positive means of air control. With mechanical draft we have a very convenient method of controlling the air supply by varying the speed of the blower and this is one of the advantages of mechanical draft. Its principal advantage, however, is in the fact that through it, greater rates of combustion (more pounds of fuel per sq. ft. of grate per hour) may be obtained resulting in a decreased excess of air. The following statement of Mr. Walter B. Snow, one of the leading experts on combustion in this country, explains the reasons for this: "If the size of the grate is reduced but the same amount of fuel burned by increasing the rate of combustion the diminished area of the grate and of the exposed insterstices between the fuel necessitates a higher velocity to secure the admission of a given volume of air. This increased velocity in turn requires greater draft or air pressure. The volume at any given temperature passing through the fuel is proportional to the velocity, but the pressure varies as the square of the velocity. Therefore if a given grate be reduced one-half and the rate of combustion doubled so as to maintain the same total consumption the same volume of air would have to travel through the exposed interstices at twice the velocity. But the pressure would be four times as great and as a consequence the air would be forced into spaces between the fuel which it would not reach under less impelling force."

EVIDENCE OF FURNACE CONDITIONS.

How can we determine whether there is complete combustion in the furnace or not? One indication of it is the color of the smoke passing from the stack. The general practice is to manipulate the draft and fire in such a manner as will prevent smoke from appearing at the top of the stack, smoke being taken as an indication of incomplete combustion. It may be and generally is an indication of CO instead of CO_2 in the furnace. The smoke itself is composed of minute particles of carbon which have risen from the fuel by reason of the draft and the agitation which comes with combustion. If the fire is hot enough and oxygen is supplied above the fuel bed, particles of carbon may be burned and the smoke prevented. It is thus noticed that the conditions for smoke consumption are the same as required for the consumption of the volatile hydrocarbons and CO rising from the fuel and that where there is no smoke we may reasonably expect thorough combustion. The loss in the smoke itself, however, is exceedingly small—in fact, so small that it could be neglected. The "no smoke sign," however, is not an infallible means of judging furnace operation for the reason that although it indicates absence of CO it does not inform us as to how much excess of air there may be. With a large excess of air, all of the carbon is almost sure to be burned to CO_2--that is, complete combustion—and there will be no smoke; yet the loss due to excess of air may be as great or greater than that due to the small loss from CO, which goes with a small amount of smoke. The careful fireman manipulates his furnace so that the top of the smoke stack is on the dividing line between no smoke and smoke—that is, a faint appearance of smoke.

The only accurate method of determining the conditions in the furnace is by flue gas analysis. Of course the gases reaching the smoke stack are those formed in the furnace and therefore their composition indicates the furnace products. This analysis is a simple matter which can be performed by any one of ordinary intelligence. A tube is inserted into the stack, or the flue leading to the stack, and a sample of the gases drawn into a vessel by a water siphon. Some instrument (the most common of which is the Orsat apparatus), is then used by which the amounts of CO_2, CO and O are determined; their sum being about 21 per cent of the total volume, the remainder (79 per cent) being principally nitrogen. Any air in the flue gas will of course be indicated by the presence of O and as some excess of air is needed at the furnace to insure the contact of oxygen with every particle of carbon, the flue gas from a good furnace will contain some oxygen. It is generally assumed that an air excess of not less than 50 per cent over that theoretically necessary should be supplied. In any case the CO should be zero or, at any rate, in very small quantities. Since air is the only source of oxygen, theoretically perfect combustion would be shown by a flue gas analysis of 21 per cent CO_2, 0.0 per cent O, 0.0 per cent CO and 100—21=79 per cent N. With an air excess of 50 per cent the gases would be diluted to that extent and the theoretical analysis would be 14 per cent CO_2, 7 per cent O, 0.0 per cent CO, and 79 per cent N. With an air excess of 100 per cent the analysis will show 10.5 per cent CO_2, 10.5 per cent O, 0.0 per centCO, and 79 percent.N. An inspection of these different analyses shows that doubling the air supply halves the CO_2. Theoretically there should be no CO in a gas having O, but owing to the fact of imperfect mixture there is usually some of both. In practice there is another reason for variation from the theoretical analysis explained above. The ordinary analysis instrument accounts for the CO_2, O and CO, when in reality, there are small quantities of steam and various oxides other than those of carbon, such as potassium, sodium, aluminium, silica, etc., which oxides constitute ash. The oxygen utilized in forming the steam, (H_2O), and oxides being unaccounted for in the analysis, it therefore shows less O than has been utilized in combustion. It is because of this and the fact that some of the hydrocarbons reach the stack unburned that the sum of the CO_2+O+CO seldom if ever sum up to the theoretical 21 per cent.

WEIGHT AND VOLUME OF AIR REQUIRED FOR COMBUSTION.

For the combustion of a pound of carbon sufficient air must be supplied to burn it to CO_2. The atomic weights of carbon and oxygen being 12 and 16 respectively, the molecular weight for CO_2 will be $1\times12+2\times16=44$, or 2.67 parts of oxygen to one of carbon. There are 0.23 parts of oxygen in one of air so that $\frac{2.67}{0.28}=11.61$ pounds of air are theoretically required per pound of carbon. A similar calculation shows that to burn hydrogen to water (H_2O) 34.78 lbs. of air are required. Assuming the temperature of the air to be 80 deg. F., the volume of one pound is 13.6 cu. ft., so that $13.6\times11.61=157.89$ cu. ft. is the volume of air per pound of carbon. Likewise for a pound of hydrogen 472.0 cu. ft. are required. The volumes just calculated are for no excess of air. For 50 per cent excess of air we would add 50 per cent to the volumes named.

CALCULATION OF AIR EXCESS FROM THE FLUE GAS ANALYSIS.

The formula for calculating the excess of air may be derived as follows: Air being composed of N and O in the ratio of 79 to 21 would indicate that for every part of O drawn into the furnace there would be =3.76 parts of N. So if the O is taken as a basis upon which to work, the following formula may be used for calculating the per cent excess of air $\frac{N}{N-\frac{79}{21}O}=\frac{N}{N-3.76O}$

(1) where N and O are the percentages of N and O found in the

flue gases. And if the CO_2 is taken as a basis the formula $\frac{21-S}{S}$ (2) may be used where S is the per cent of CO_2 in the flue gas. Unless the CO_2+O+CO add up to 21 neither of the above formulas are absolutely correct. No. 1 deals with the O and N. It must be remembered that any O present signifies an excess of air; if the CO_2+O+CO is less than 21 it means a larger per cent of N than 79 since N is obtained by difference; and any CO present signifies an O consumption which is not accounted for in the formula. Therefore the excess air by formula No. 1 is always too low unless theoretical conditions evist. Formula No. 2 deals with the CO_2 only, and like No. 1, is only correct under the same conditions. Since in the combustion of bagasse there is little or no free hydrogen or CO and as the sum of the CO_2+O+CO more nearly equals 20 than 21, the formula $\frac{20-S}{S}$ will be used.

FORM AND PROPORTIONS OF FURNACE.

In the light of the discussions just passed it is clear that in practice, due to the impossibility of maintaining uniform conditions in the thickness of the fuel bed, air supply, etc., there will be many different streams of chemical compounds in the form of gases rising from the fuel bed, such as CO_2, CO, hydrogen, methane, air, etc. For instance, those parts of the fuel bed that are comparatively thin will give CO_2; where the fire burns through, air will pass; where the fuel is thrown in thick piles CO will form, etc. In addition to this, air may be admitted to the combustion chamber through the fire doors, the bridge wall, etc., and the form of the furnace must be such as will facilitate a complete mixture of all these different streams so as to bring about the chemical combinations necessary for completing combustion, and to allow the necessary time for such combustion. In the ordinary coal furnace with return tubular boilers, the mixing is taken care of by the form of the bridge wall and the combustion is facilitated by making the furnace or combustion chamber as large as practicable. The front face of the bridge wall is made sloping so as to reflect the impinging gases in a manner such that all the gases will be mixed. In fact, it is just at this point that the highest temperatures in a furnace of this kind are found, which high temperatures are due alone to the fact that the mixing at that point causes further combustion and heat generation.

Various arrangements in the form of baffle plates, abrupt change in direction of the gases, etc., have been made in different furnaces with this in view. The settings for the different types of water tube boilers, especially, furnish many different types for this purpose. It is evident that the more perfect the mixing device, the smaller the quantity of excess air required for complete combustion. The form and size of the furnace above and back of the fuel bed can only affect the combustion of the gases rising from it, and as these gases are cooled immediately upon coming in contact with the heating surface, the temperature of the water on the other side of which is very low (relatively), this combustion should be made to take place before the heating surface is reached. As the distance from the grate to the heating surface is short, the velocity of the gases should be made as small as possible in order to give the time necessary for combustion. This can only be done by making the combustion chamber as large as possible. This is especially necessary with fuels giving off large volumes of volatile gases or which have much moisture. The simplest way of doing this with H. R. T. boilers is to increase the distance between the grate and the boiler shell and by battering the furnace walls so as to give more space between the walls and the boiler at the sides. Another method is to make a separate furnace and place it entirely in front of the boiler so as to increase the size of combustion chamber and give more time for combustion of the gases before they are cooled below the ignition temperature. This is called a ''dutch oven'' furnace. With a large combustion chamber it is possible to make use of another aid to the combustion of the gases provided there is both a chimney and a blower for forced draft, by producing what is known as a ''balanced draft'' and thereby a lower velocity of the gases. With an arrangement of this kind, the stack clearly operates to produce a vacuum at its base. On the other hand, the blower produces pressure and if the stack damper and the speed of the blower are properly manipulated it is evidently possible to bring about a neutral condition in the furnace. For instance, suppose the draft gauge shows some vacuum in the furnace, with the blower running at a given speed; a partial closing of the stack damper will decrease that vacuum and it is simply a matter of adjustment to find the neutral condition which will reduce the velocity of the gases in the furnace. In such a furnace, the flames will be seen to roll and reverberate instead of passing in a thin sheet quickly to the stack, this rolling or eddying effect helping also in the process of mixing, which is highly important. In any furnace it is important to have the combustion space as nearly enclosed within highly heated brick surfaces as possible, the walls radiating their heat in such a manner as to keep the high furnace temperature constant, counteracting the changing temperature due to opening of the fire door, fresh charges of fuel, etc.

Finally with reference to the furnace, it may be said in the words of a leading authority "that furnace is most efficient which completely consumes the combustible with the least surplus of air," or, in the words of another authority, "the most efficient furnace is one which will deliver to the boiler the greatest weight of gases at the highest temperature from a given amount of fuel."

TRANSMISSION OF HEAT FROM FURNACE TO BOILER.

Let us suppose that a maximum amount of heat has been evolved from the fuel in the furnace; it will now be in order to discuss the conditions necessary for the transmission of a maximum amount of this heat through the metals walls of the heating surface into the boiler. It is evident that this question is one with which the boiler as well as the furnace is concerned.

The transmission of heat is always from a hot body to a cooler one and the flow is proportional to the difference in temperature. The metal walls of the boiler offer resistance to the flow of heat from the gas side to the water side which makes it all the more important to make the temperature difference as great as possible. This can be done by making the furnace temperature greater or by making the temperature of the water or steam less. The temperature of the water cannot be varied greatly as it is proportional to the steam pressure carried. For instance, at a pressure of 100 lbs. gauge, the temperature is 337 deg. F., at 50 lbs. gauge it is 280 deg. and at 150 lbs. gauge it is

365 deg. F. Some engineers of the early days, in fact, advocated low steam pressure on this account.

The temperature in the furnace is affected by the rate of combustion, the amount of air supplied, the fuel, the amount of moisture in the fuel, the form and proportions of the furnace, etc. The formula, due to Rankine for the theoretical temperature of the furnace, is $Tf = \frac{W x Sp}{Q}$, in which Tf denotes the temperature of the furnace in degrees F. above that of the air; Q, the heat units due to the combustion of one pound of the fuel; W, the weight of the products of combustion in pounds per pound of fuel and Sp the specific heat of the products of combustion. The values of Sp. are: for CO_2, .217; air, .237; steam, .55; N., .244, and ashes, .200, the average of which is .281. According to this formula an anthracite coal having a heat value of 12500 B. T. U. per pound, and requiring say 12 pounds of air per pound of fuel, would give a theoretical furnace temperature of $Tf = \frac{12500}{(12+1) \times 0.281} - 3420$ deg. F. with no excess of air. With 100% air excess we would have $Tf = \frac{12500}{(24+1) 0.281}$ $=1778$ deg. F. A similar application of this formula for 200 per cent excess of air gives a temperature of 1202 deg. F. These figures, though theoretical, are not far from those obtained in actual practice and show very plainly the harmful effects of an air supply beyond that necessary for complete oxidation. The effect of the form and proportions of the furnace upon the furnace temperature by bringing about thorough mixing of the products and therefore better combustion has already been discussed. Moisture in the fuel reduces the temperature because part of the heat of combustion is required to convert the moisture into steam, which robs the products of that much heat. The number of B. T. U. that can be transmitted through the walls of the heating surface by a given area in a given time depends upon the metal of the wall as well as upon the thickness. For instance, copper or brass will transmit heat more rapidly than wrought iron or steel and the transmission will be greater through thin than thick metal. In early days some boilers were made of copper—in fact, the fire boxes of locomotives and some small boilers have been made quite recently of this material. However, in modern practice wrought iron or steel are required to resist the higher pressures used, the result being that the metals having high heat conductivity are used little—in fact, not at all with high pressures.

With a given difference of temperatures, therefore, the flow of heat through the metal of the heating surface is limited, a point being reached where the tendency for the heat to pass on to the stack is greater than the tendency to pass through to the water, the result of which is to cause more heat to pass out through the stack. Such a condition as this will be indicated by a high temperature of the smoke stack gases. It has been found in practice that the evaporation of about 3 pounds of water from and at 212 deg. per sq. ft. of heating surface per hour is that which results in good economy. This is equivalent to saying that under the ordinary conditions of stationary practice not more than 965.8×3=2897 B. T. U. can be transmitted per square foot of heating surface per hour without reducing the economy or, in other words, without increasing the stack temperature. Of course it is possible to evaporate much more than the above figure and any boiler is expected to take overloads in cases of emergency, but as this is done at considerable fuel loss, it should be for short periods only.

RATIO OF HEATING SURFACE TO GRATE SURFACE.

The quantity of heat generated in a furnace is, other things being equal, proportional to the area of the grate and the quality of the fuel, and it is therefore necessary to proportion the area of the grate so it will furnish just enough heat, under normal conditions of operation, to evaporate about 3 pounds of water from and at 212 deg. per sq. ft. of heating surface per hour. Since, under normal conditions, the heat absorbed by the boiler is proportional to the area of the heating surface, it follows that the ratio, area of the heating surface divided by the area of the grate surface should be carefully determined. This ratio will depend upon many things, principal of which are the quality of the fuel and the number of pounds of fuel that can be burned per square foot of grate surface per hour (rate of combustion). The quality of the fuel determines the number of pounds of water that one pound of it will evaporate from and at 212 deg. This is determined of course in evaporative tests by dividing the evaporation from and at 212 deg. per hour by the weight of fuel burned per hour.

A report of 78 tests made at the U. S. Fuel Testing plant at St. Louis on bituminous coals and lignites showed an average equivalent evaporation from and at 212 deg. of 8.73 lbs. of water per pound of combustible, and varying from 6.1 to 10.74. A large number of tests by Mr. Barrus with anthracite showed an average equivalent evaporation of about 11 pounds of water per pound of combustible. The rate of combustion (pounds of fuel burned per square foot of grate surface per hour) depends principally upon the nature of the fuel and the draft. For instance, less anthracite can be burned per sq. foot in a given time than can be burned with bituminous coal, on account of the slow burning quality of the former. Then, too, the finer sizes of anthracite coal will burn less rapidly than coarser sizes as the particles pack so closely as to prevent the access of the air required for rapid combustion unless mechanical draft is used. Clinkering coals cannot be burned very rapidly. This means that if the rate of combustion is small, the grate must be made larger in order to generate a required amount of heat; also if the quality of the fuel is such as to give it a low heat value, a greater number of pounds must be burned than for a better fuel which means a larger grate surface. The following figures taken from Meyer's Steam Power Plants are useful for determining the ratio of heating surface to grate surface:

Kind of Coal	NAME	Pounds of water 1 lb. of coal will evaporate from and at 212 deg., ordinary conditions.	Pounds of coal per sq. ft. of grate surface per hour.
Semi Bituminous	Pocahontas, W. Va.	9.5	15
Bituminous		8.7	17
"	Hocking Valley, O.	7.6	18
"	Big Muddy, Ill.	7.6	20
"	Mt. Olive. Ill.	6.4	20
Anthracite, broken	Lackawanna, Pa.	8.5	15
" , Buckwheat	"	7.5	13
" , Rice	"	7.0	12

For example, let us calculate the ratio of heating surface to grate surface for the anthracite rice coal at the bottom of the above table. Since one pound of coal will evaporate 7 pounds of water from and at 212 deg., one sq. ft. of grate surface will burn coal sufficient to evaporate $12\times7=84$ lbs. of water from and at 212 deg. per hour. Assuming that 3 lbs. can be evaporated by one sq. ft. of heating surface per hour, the ratio of heating surface to gate surface is $\frac{84}{3}=28$. A similar calculation for Pocahontas coal gives a ratio of $\frac{15\times9.5}{3}=47.5$. The heating surface of Horizontal Return Tubular boilers may be correctly assumed at 12 square feet per horse power. For a 100 horse power boiler, then, there would be $12\times100=1200$ square feet of heating surface. If anthracite rice coal is to be burned under it, a grate surface of $\frac{1200}{28}=42.8$ sq. ft. would be required. Should it be found advisable afterward to burn Pocahontas coal in this furnace its grate area should be decreased to $\frac{1200}{47.5}=25.2$ square feet, otherwise the fuel bed would have to be kept so thin as to make it impossible to prevent holes burning through and causing loss due to the cooling of the furnace. The above calculation is given to show the principles involved as well as the importance of having this question carefully considered. A matter of such importance as this should be submitted to an engineer. As explained above, 3 pounds of water evaporated from and at 212 deg. per sq. ft. of heating surface should be assumed as normal because higher rates increase the stack temperature and reduce the evaporation per pound of fuel. A boiler is said to be ''forced'' when making such high rates of evaporation.

On the following page is a curve showing the relations of economy to rate of evaporation which was plotted from the results of tests made upon a Stirling boiler. It will be noted that the maximum of pounds of water evaporated per pound of fuel is obtained with 2 lbs. of water per sq. ft. per hour instead of 3 pounds. This would require, however, an increase of 50 per cent in the heating surface for a given H. P. and therefore a large increase in first cost, which, counting the interest on the investment, would not be profitable. The slightly decreased economy and less first cost resulting from an evaporation of 3 lbs. per sq. ft. per hour is a compromise.

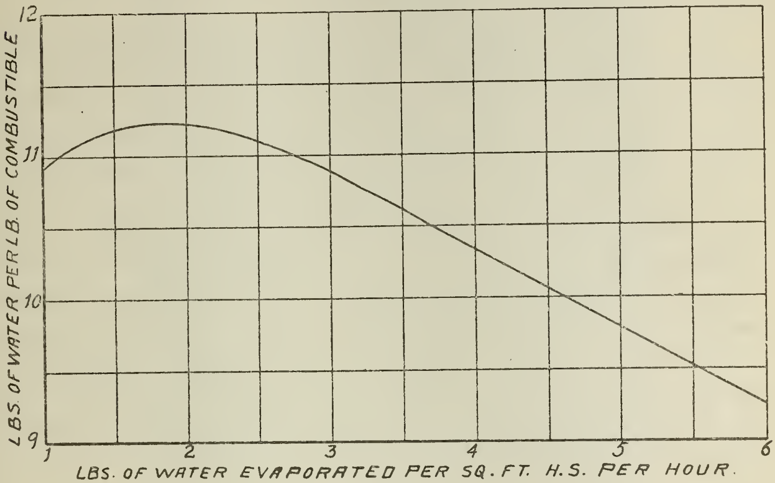


Fig. 1.

Stack Temperature.

A high stack temperature is always an indication of reduced economy, though it may not always be due to excessive rates of evaporation. For instance, it may be due to accumulations of soot on the gas side of the tubes or heating surface or of scale on the water side. In this case the resistance to heat transmission is such as to make the heat pass directly to the stack, even with low rates of evaporation. Then, again, it is possible, under certain conditions, to have combustion of CO to CO_2 take place at the base of the stack, especially if there happens to be openings in the breaching for the admission of air. One would naturally expect the stack temperature to vary directly with the furnace temperature and such is generally the case, other things being equal, though the opposite sometimes occurs. For instance, with a very large excess of air supplied to the fuel the temperature of the furnace is lowered yet by reason of the larger volume of gases passing through (including the excess of air) their velocity is so greatly increased as to prevent the time of contact with the heating surface necessary for absorbing their heat, the result being a high stack temperature. In view of the discussions above it is evident that with a given fuel the larger the ratio of heating surface to grate surface the lower the stack temperature, other things being equal.

In a properly designed and operated boiler plant the temperature of the products of combustion should be reduced to something like 500 deg. F., or less by the time they reach the base of the smoke stack. Out of about 140 tests made on different boilers in New England by G. H. Barrus, sixty showed a flue gas temperature of less than 400 deg. F., and only 21 with temperature over 500 deg. F., the average being in the neighborhood of 415 deg. F. By evaporative tests the same authority found that with a decrease of 100 deg. F. in the stack temperature, the evaporation per pound of fuel was increased 6 per cent. A curve is here presented showing relations between stack temperature, water evaporated from and at 212 deg. per sq. ft. of heating surface per hour and the quantity of heating surface required per horse power.

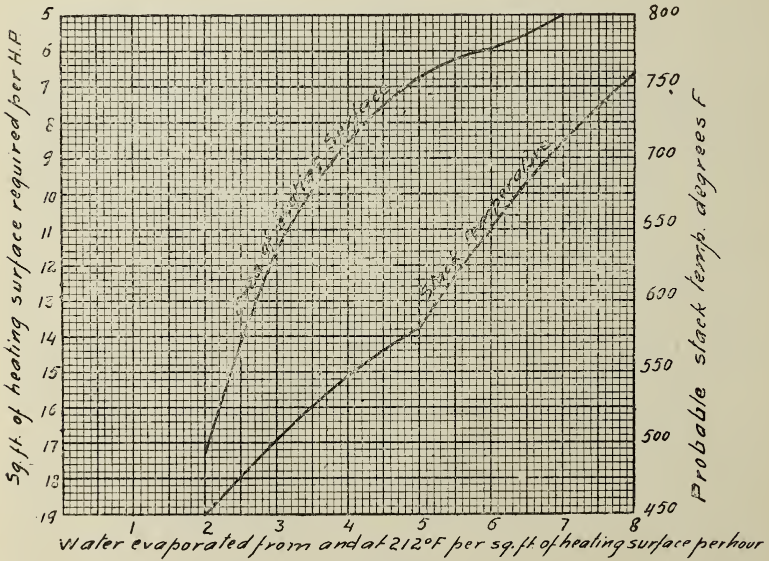


Fig. 2.

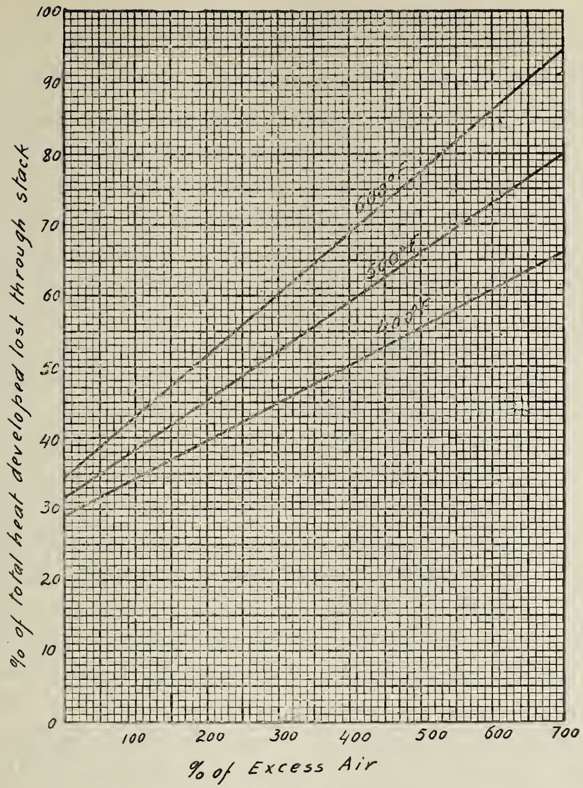

% of total heat developed lost through stack
100
90
80
70
60
50
40
30
20
10
0
100
200
300
400
500
600
700
% of Excess Air
600°F
500°F
400°F

Fig. 3.

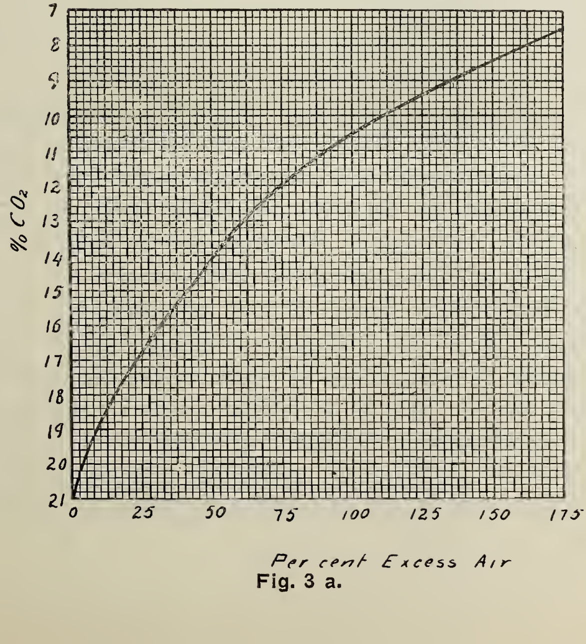

% CO₂
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
0
25
50
75
100
125
150
175
Per cent Excess Air

Fig. 3 a.

BAGASSE AND BAGASSE FURNACES.

In the light of the above discussion of the conditions required for the efficient production and utilzation of the heat of fuels in general it will now be in order to take up the question of bagasse and discuss the special conditions met with and the special problems that must be solved for its efficient combustion. As a fuel bagasse differs from other fuels mainly in that it is very bulky; it contains an excessive amount of moisture and, being very porous, carries into the furnace a large quantity of air. Its general composition has already been treated of at length on pages 10-12 and its gross and net fuel values on pages 14-15, also in table A. The products of combustion for this fuel are much the same as for the fuels already discussed—that is, the carbon burns to CO_2 with sufficient air supply and to CO with insufficient air supply. The large amount of free moisture in the fuel added to the moisture produced by the combination of hydrogen and oxygen in the fiber and sugar, coming in contact with the heat of the furnace, produces large volumes of superheated steam which rises with the carbon oxides and hydrocarbons from the burning fuel bed.

Owing to the fact that the H and O exist in the fuel in the exact proportions to form water, they combine without the formation of heat so that theoretically the carbon constitutes the heat-producing element.

EFFECT OF MOISTURE IN BAGASSE.

It is held by some that with high furnace temperatures the moisture in bagasse is decomposed into its constituent elements, hydrogen and oxygen, and that some beneficial or economic result is obtained by the burning of the hydrogen and using the oxygen for combustion. In other words, that the moisture is advantageous. This assumption is incorrect.

R. S. Hale (R. S. Hale's Report on Efficiency of Combustion, Steam Users' Assn., Boston, Circular No. 9) states that decomposition or dissociation of water in the furnace begins at about 1832 deg. F. It may be noticed (table V) that the highest furnace temperature in Louisiana or Cuba was 1700 deg. F.

For convenience consider 18 lbs. of bagasse at 32 deg. F. and 50 per cent moisture; a furnace temperature of 1600 deg. F., and a stack temperature of 500 deg. F. Under these conditions 9 pounds of water would be driven off in the furnace and pass out of the stack as steam at 500 deg. F. having undergone no change except in temperature. One pound of H_2O passing from H_2O at 32 deg. F. to superheated steam at 500 deg. F. will absorb $212-32+966+(500-212).52=1296$ B. T. U., and 9 lbs. will absorb $1296\times9=11664$ B. T. U., which is an absolute loss.

With a furnace temperature of 2000 deg. F. dissociation of the 9 pounds of steam into its elements will take place and there will be liberated 8 lbs. of oxygen and one pound of hydrogen. (Hydrogen and oxygen combine in the proportion of 2 of H to 1 of O by volume and 1 of H to 8 of O by weight). This decomposition will absorb 62000 B. T. U., which will tend to chill the furnace. Hydrogen combines with oxygen to form steam only and if this pound of hydrogen recombines with eight pounds of oxygen to form 9 pounds of steam, 62000 B. T. U. will be evolved, but under these furnace conditions, as shown above, 11664 B. T. U. is not available, giving a net thermal value of one pound of H=50336 B. T. U.

Now suppose the hydrogen to remain uncombined and the oxygen to be utilized in combining with the carbon of the fuel.

The eight pounds of O may enter into combination with the 6 pounds of C, forming 14 pounds of CO (since CO is composed of 12 parts of C to 16 parts of O) generating $6\times4500=27000$ B. T. U., which is 25000 B. T. U. less than that absorbed. Considering the most favorable conditions, the eight pounds of O may enter into combination with the 3 lbs. of C, forming 11 lbs. CO_2 (since CO_2 is composed of 12 parts of C to 32 parts of O) generating $3\times14600=43800$ B. T. U., which is 18500 B. T. U. less than was absorbed.

From the data on hand it may be seen that an excess of air is always present and O from the decomposed steam is not needed. If the furnace temperature should be high enough to decompose the steam into its elements, thereby absorbing heat, these elements would recombine to form steam upon being cooled later in its passage through the boiler, thereby liberating the heat previously absorbed. It is clear, therefore, that in any case the moisture is a source of loss, though if the temperature of dissociation can be produced in the furnace some of the loss may be recovered.

AIR SUPPLY FOR BAGASSE BURNING.

By reason of the open porous condition of bagasse causing it to carry in a large quantity of air with it, a comparatively small amount of air has to be supplied through draft. The theoretical weight of air per pound of bagasse based on that required to burn the carbon, which for a problem already solved was found to be 21.5 per cent, would be (see page 21) $0.215 \times 11.61 = 2.49$ pounds and for an air excess of 50 per cent $2.49 \times 1.5 = 3.73$ pounds. The volumes corresponding to the above would be $2.49 \times 13.6 = 33.8$ cu. ft. for no air excess and $3.73 \times 13.6 = 50.7$ cu. ft. for 50 per cent air excess. As much air comes in with the fuel, less than this will have to be furnished through draft.

The method of obtaining the draft in bagasse furnaces varies considerably, some being with natural and some with forced draft. In Louisiana the forced draft is used by a large majority. It may be said, however, that on account of the method of feeding the bagasse to the furnace through a hopper, which must be open all or at least a part of the time, forced draft can be used only in conjunction with a chimney; otherwise the pressure in the furnace will be such as to force the smoke and sometimes sparks out through the hopper. In any case, a stack must be provided with height sufficient to insure a slight vacuum in the furnace. (See page 18.) With this arrangement the balanced condition of draft already mentioned is easily obtained. As the feed hopper is open, at least part of the time, there is a large inflow of cold air into the furnace in cases where there is considerable vacuum in the furnace, such as results with chimney draft alone. Many hoppers are therefore arranged to automatically close and open periodically so as to reduce the amount of air excess from this source. There is the same need of air above the fuel in a bagasse furnace as in other furnaces, but so large an opening admits much more than is necessary and besides this, the location of this air entrance is such as to make it difficult to properly mix the air with the products rising from the fuel bed. On the other hand, with those furnaces having the combination of a blower and a chimney and in which the equilibrium of pressures may be produced, the tendency for air inflow is reduced to such a small amount as to make the automatic closure of the hopper, mentioned above, of little importance, especially as the admission of a small quantity of air is of real advantage. For forced draft, the blower method is used almost exclusively for supplying the air though steam jet blowers are occasionally found in use. The methods for distributing the air to the fuel are three in number: (1) the discharge pipe from the blower discharges into a header, usually at the bridge wall, and this header supplies air to hollow grate bars having holes in their surfaces through which the air flows, under pressure, to the fuel. (See fig. XII); (2) the blower discharges into a closed ash pit from which the air flows upward through the ordinary grate bars to the fuel and (3) the blower discharges into an air chamber at the back and sides of the furnace from which it passes through tuyeres in the furnace walls to the fuel, (Hearth type) see fig. 5. In this type there are no grate bars, the fuel resting upon a fire brick floor. In addition to the arrangements described above, there are various combinations of the three types. For example, Fig. XI shows a combination of types 1 and 3. In Louisiana, however, type No. 1 is the one used in most cases. This type when working in good order gives a better distribution of air through the bagasse than the others, the air leaving the hollow grate bars in a great number of small streams. There is danger however, of the small holes being clogged by the clinker which forms from the fusion of potash and silica in the bagasse, also by the weight of the bagasse itself. Various forms of grate bars have been patented and used, the object of which is to overcome this difficulty. In some of them the openings are in depressions of the bar and so protected to some extent, from closure. The principal objection to this type as well as to all grate furnaces is the difficulty due to the closure of not only the opening of the hollow bars but of the ordinary bars as well by clinker which at very high temperatures melts and runs, and after cooling is hard to loosen. The high temperatures are also very destructive to the iron bars so that their repair becomes an item of considerable expense. The hearth type does away with the difficulties attending grate furnaces, due to clinkers, and the arrangement otherwise seems to facilitate good combustion. As there are no metal grate bars, higher rates of combustion, and therefore higher furnace temperatures are possible than with the grate furnaces, and this in turn should give better combustion and better heat transmission from gases to water. Comparing the natural and forced draft systems, the same reasoning holds as for other fuels, viz., that with forced draft the rate of combustion may be increased and the air excess cut down, resulting in higher furnace temperatures and that the blower furnishes better opportunity for controlling the air supply by varying the speed of the blower. On the other hand, chimney draft has proven itself efficient and has one very excellent quality to its credit, viz., that of simplicity in operation. Besides this it does away with the blower engine which requires a considerable amount of steam for its operation.

The size of the grate for a given capacity depends upon the quantity of bagasse that can be burned efficiently upon one square foot of grate per hour, and this in turn depends mainly upon the per cent of moisture in the bagasse and the intensity of the draft. There seems to be no doubt, however, that it pays to make the draft strong enough to give as high rates of combustion as possible, which means a relatively small grate, or in other words, a large ratio of heating surface to grate surface. To show the method of arriving at these figures, let us assume that 100 pounds of bagasse can be successfully burned per square foot of grate, that 2.5 pounds of water can be evaporated by one pound of bagasse and that the boiler is to be 100 H. P. For every square foot of grate therefore $2.5 \times 100 = 250$ pounds of water will be evaporated from and at 212 deg. per hour. There will be $12 \times 100 = 1200$ square feet of heating surface and $1200 \times 3 = 3600$ (see page 26) pounds must be evaporated from and at 212 deg. per hour for normal running. The grate surface will therefore be $\frac{1600}{250} = 14.4$ square feet, and for 33⅓% overload $14.4 \times 1.33⅓ = 19.2$ square feet. For a further discussion of this see page —.

If the grate is too large the bagasse falling as it does from one point above the middle of a usually pyramidal pile, will fail to cover the outer edges of the grate, or if it does, in very thin layers, burns through in spots. The result of this is that the air takes the path of least resistance and the largest portion of it passes through these open parts of the grate while the middle of the pile, which requires most, gets the least.

Bagasse, being of an open, light quality, is not so likely to pack together as coal and it is comparatively easy to burn it in a thick bed, provided there is sufficient draft pressure.

SIZE OF COMBUSTION CHAMBER AND PASSAGES.

On account of the large amount of moisture in bagasse which is converted into steam in the furnace, a volume of gas and steam much larger than for coal must be accommodated in the combustion chamber and the passages to the stack.

VOLUME OF GASES FORMED FROM BAGASSE.

Assuming a bagasse of the consistency given in the table on page 12 it is an easy matter to calculate the volueme of gas and steam reaching the stack, per pound of bagasse.

Considering the bagasse of the composition mentioned, in which the total C. is .215 lb. and total moisture .79 lb., and remembering that the air required to burn .215 lb. C to CO_2 is 2.49 lbs., we will have $2.49+.215=2.7$ lbs. CO_2. For 50% excess air there will be $2.49\times.5=1.25$ lbs. air also. In addition to this we will have a volume of steam generated from .79 lb. of water. The volume of 2.7 lbs. CO_2 at 32° is 21.871 cu. ft.; that of 1.25 lbs. air at 80° F. is 17.0 cu. ft., and that of .79 lb. steam at 212° or atmospheric pressure (the furnace pressure) is 26.6 cu. ft. The volume of a gas is proportional to its absolute temperature; in other words the higher the temperature of a given quantity of a gas (the pressure remaining the same) the greater its volume. Air and CO_2 are perfect gases. Steam, however, is not really a perfect gas, though at the high temperatures existing in the furnace and stack it may be considered so, for all practical purposes.

Let us now calculate the volume of gases reaching the stack at a temperature of 500° F., corresponding to an absolute temperature of $500+461=961°$.

The volume of 2.7 lb. CO_2 at the stack temperature would be $21.87\times\frac{961}{32+461}=43.2$ cu. ft.; that of the 1.25 lbs. air would be $17\times\frac{961}{461+80}=30.06$ cu. ft., and that of the .79 lb. steam would be $26.6 \times \frac{961}{673} = 31.90$ cu. ft. The sum of these makes 105.16 cu. ft. of gases reaching the stack. A similar calculation gives a total of 227.3 cu. ft. of gases and steam at a temperature of 1500° F. or 1961° absolute in the furnace with an air excess of 50% as before. For 100% air excess, similar calculations give a total of 135.22 cu. ft. per pound of bagasse at the stack and 289 cu. ft. at the furnace. A calculation like the above for a pound of bituminous coal, consisting of 83.5% C, 4.6% H and 3.15% O gives volumes of 314.3 cu. ft. and 447.9 cu. ft. of gases and steam entering the stack at 500° F. for air in excess of 50% and 100%, respectively, and in the furnace 640 cu. ft. for 50% excess and 911 cu. ft. for 100% excess.

Referring to columns 14 and 15 of Table "A," we find that the equivalent of 1 lb. of coal, in the bagasse under consideration, is 5.54 lbs. for 50% air excess and 5.85 lbs. for 100% excess. For convenience, the following table is arranged so that comparisons may be drawn by considering quantities in the same vertical column. The lower row of values is gotten by multiplying the values in the top row by the number of pounds of bagasse equivalent to 1 lb. of coal. The comparison shows clearly the larger volume of gases coming from bagasse, due largely to the moisture in it. It will be noticed that as the air excess is increased the difference (relative) becomes less, due to the fact that the moisture becomes a smaller portion of the total.

TABLE SHOWING THE RELATIVE VOLUMES OF GASES GENERATED BY BAGASSE AND COAL.

	At Stack 500° F.		At Furnace 1500° F.	
	50% excess.	100% excess.	50% excess.	100% excess.
Volume of gases from 1 lb. of bagasse........	105	135	227	289
Volume of gases from 1 pound of coal........	314	640	447	911
Volume of gases from bagasse equivalent to 1 lb. coal..............	681	791	1258	1690

These calculations of the volume of gases generated by the combustion of bagasse are given for the purpose of showing clearly the importance of large passages in the setting and flues as well as a large combustion chamber. A similar calculation would have shown that for anthracite coal the volumes generated would have been still less than for bituminous coal. In practice this is shown in the fact that the furnaces as well as the passages and flues are made of larger dimensions for bituminous than for anthracite coals. For instance, the proper height of the combustion chamber (distance from grate to under side of boiler) for an H. R. T. boiler is 28 to 30 inches for anthracite coal and 36 to 42 inches for bituminous coals. From this we see also that the dimensions referred to must be still larger for bagasse furnaces on account of the still greater volume of gases. In all cases too small dimensions cause high velocity of the gases. A small furnace causes them to leave too quickly for their complete combustion, small passages cause a high velocity, which, in turn, causes friction and consequent reduction of draft; reduced tube area causes a high velocity in the tubes which prevents, in turn, the time of contact with the heating surface necessary for heat transfer. The stack, too, as it has a larger volume of gases to handle, must be larger for bagasse than for coal furnaces of the same capacity.

In the enlarging of the combustion chambers many different lines of design have been followed, the simplest being that of increasing the height of the boiler above the grate. In few cases is this distance made less than 48 inches and generally more. In the description of furnaces later in this bulletin, mention is made of one furnace of this type in which this distance was 96 inches (see Fig. XVII). Another type is that in which the bagasse is burned in a separate oven, which is connected by a passage of more or less length to the boiler, as in Figs. IX, XII and XVI. The oven may be of the grate type or of the hearth type, and it may be placed directly in front of or at the side of the boiler, the former being called a dutch oven. Often the oven is placed so as to furnish heat for two boilers (see Fig. XV). The oven type of furnace is more costly than the ordinary type, but it is evident that it fulfills the requirements for combustion much better by reason of the fact that the combustion chamber can be made larger, and for the further reason that the combustion can be completed before the products reach the heating surface of the boiler, which tends to cool them to below the burning temperature. The necessary volume can, of course, be obtained with the ordinary (sometimes known as the Burt type) furnace by raising the boiler sufficiently high above the grate, but this still has the disadvantage of having heating surface for the top of the furnace, which cools the products and admits of little opportunity for mixing and combustion. The hearth furnace, as in Fig. V, when placed under the boiler, admits of a larger height of furnace without raising the boiler so high, but it is open to the same objections as for the above as far as the cooling of the products and mixing are concerned.

In general it may be said that the combustion should take place in a chamber as nearly completely surrounded by highly heated fire brick as possible. The oven type of furnace comes nearest fulfilling this requirement and, besides its more or less long and small passages to the boiler, compels the mixing so necessary for combustion. The oven type of furnace, however, has the disadvantage of the Burt type, in that its upkeep as well as its first cost is greater. This is due to the fact that the top of the furnace must be supported by an arch. As we should expect, the temperatures are higher on account of the better combustion, and this causes fusion of the bricks, which fall, especially from the top, where replacement is difficult. The cost of repairs, however, can be avoided by careful construction of the furnace.

AREA OF PASSAGES AND TUBES.

It is a simple matter to proportion the passages above the bridge wall at the back connection, at the flue, at the stack, etc., by increasing the areas used for, say, bituminous coal in the ratio of the volumes of gases generated. The area through the tubes can be increased by making the tubes of larger diameter and smaller in number. The heating surface of a tube is proportional to its diameter, while its area is proportional to the square of its diameter. For example, doubling a 3-inch tube of a given length would double its heating surface, but at the same time treble its area.

TEMPERATURE OF THE FURNACE.

On account of the great quantity of moisture and other constituents in bagasse, the calculation of the theoretical furnace temperature is more complex than that where the fuel is pure carbon (page 25).

As it has been stated that the effect of air excess is to reduce the temperature it will be in order, to make calculations which will show the effect of air excess upon the temperature. The following is based upon a formula taken from "Kent's Steam Boiler Economy." We will use a bagasse of the same constituents already used in other calculations.

Let $H_1 = {}^*H - \frac{O}{8}$ = available hydrogen............ = 0.0
W = moisture in fuel, lbs.................... = .51
$9\,H$ = moisture of formation, lbs............. = .28
$W + 9\,H$ = superheated steam in gases....... = .79
a = heat value of 1 lb. carbon, B. T. U....... =14,600
b = heat value of 1 lb. hydrogen, B. T. U...... =62,000
f = dry gas per lb. of fuel, lbs............... = 2.93
c = specific heat of the gas.................. = 0.24
L = heat of vaporization at 212°............ = 966
T = elevation of the temperature of the fire above that of the atmosphere.
t = initial temp. of bagasse.

The total heat developed by burning 1 lb. of the fuel will be $a\,C + b\,H_1$, B. T. U. All this heat will be utilized in raising the temperature of the gas and steam to T° above that of the atmosphere. The dry gas will contain $c\,f\,T$ B. T. U. and the superheated steam.

$$(W + 9\,H)\,[212.9 - t + L + .52\,(T + t - 212)]\ \text{B. T. U.}$$

We then have

$$a\,C + b\,H_1 = .237\,f\,T + (W + 9\,H)\,[212.9 - t + L + .52\,(T + t - 212)]$$
$$= [.237\,f + (W + 9\,H)\,.52]\,T + (W + 9\,H)\,(1077 - .52\,t)$$

---

*For every part, by weight of H there are 8 parts of O; therefore there would exist no available H, for the H and O would combine to form H_2O, which is represented by 9 H.

Transposing,

$$T = \frac{a\,C + b\,H_1 - (W + 9\,H)\ (1077 - .52\,t)}{0.237\,f + .52\ (W + 9\,H)}$$

Substituting for a, b and H_1 their values,

$$T = \frac{14{,}600\,C + 62{,}000\ (H - \frac{O}{8}) - (W + 9\,H)\ (1077 - .52\,t)}{0.237\,f + .52\ (W + 9\,H)}$$

The expression $62{,}000\ (H - \frac{O}{8}) = 0.0$ (see footnote on page 41).

Bagasse, being an endothermic compound, *i. e.*, capable of evolving more heat than is accounted for by its chemical composition, the above formula may be made applicable to bagasse as follows: As already stated, the average heat value of dry bagasse, as found in these investigations, was found to be 8375 B. T. U. per pound.

Let D = % dry matter in bagasse (fiber + sucrose, etc.) = 49. The formula becomes

$$T = \frac{8375\,D - (W + 9\,H)\ (1077 - .52\,t)}{0.237\,f + .52\ (W + 9\,H)}$$

Substituting for D, W, 9 H, t and f, their values,

$$T = \frac{8375 \times .49 - .79\ (1077 - .52 \times 80)}{.237 \times 2.93 + .52 \times .79} = 2958^\circ \text{ F.}$$

above that of the atmosphere. 2958 + 80 = 3038° F. is therefore the temperature due to perfect combustion and no air excess. Substituting 4.3 for 2.93 (pounds of dry gases) in the above formula, gives a temperature of 2360° F. with an air excess of 50%, or a reduction of the temperature of 678°, due to 50% air excess.

A general discussion of the means for avoiding air excess has already been made on pages 18 and 19. The same holds in the combustion of bagasse. The temperature reducing effect of excess air is sometimes decreased by preheating the air supply. This is done by passing the air through tubes surrounded by the smoke stack gases, thus utilizing heat that would otherwise be wasted. However, it should be remembered that this will reduce the draft. An example of such an arrangement is seen in Fig. XVIII. The writer has seen furnaces in which the air is preheated by passing it through that portion of the furnace between the bridge wall and the back end of the boiler. This is of little value for the reason that the temperature of the air is increased at the expense of heat which should be given to the boiler itself.

Loss of Heat in the Flue Gases, Bagasse Furnaces

The temperature of the flue gases may be taken as an indication of the efficiency of the boiler plant in utilizing the heat of combustion and, as stated before, should not be above 500° F., higher temperatures indicating too great loss through the stack. The question naturally arises, what per cent of the heat generated is lost with a given stack temperature. A bagasse of the same compostion as that already used will be made use of.

Assume a fire-room temperature of 80° F. and a stack temperature of 500° F. The flue gases are composed of products of combustion, excess air, and steam.

Let X = B. T. U. lost through the stack per pound of bagasse.

T = temperature of stack........................ = 500° F.
t = temperature of fire room.................... = 80° F.
Specific heat of gases............................ = 0.237
Specific heat of steam............................ = 0.520
f = weight of dry gases per pound of fuel, lbs.. = 2.93
$W + 9H$ = superheated steam in gases per pound of bagasse............................ = 0.79
L = heat of vaporization at 212° F............ = 966.0

Then $X = T - t\ (.237\ f) + [212 - 80 + 966 + (500 - 212)\ .52]\ (W + 9\ H)$

Substituting values we have

$X = 500 - 80\ (.237 \times 2.93) + [212 - 80 + 966 + (500 - 212)\ .52] \times .79 = 1294$ B. T. U. This is for no excess air. Assuming the calorific value of 1 pound of dry bagasse as 8375 as before and that a pound of bagasse as fired contains 49% dry matter, the calorific value of the latter will be 8375 × .49 = 4100 B. T. U. The heat lost through the stack is therefore $\frac{1294}{4100} \times 100 = 31.6\%$ of that in the fuel. Assuming 5% loss due to radiation from the boiler and setting we get (4100 — 1294) × 0.95 = 2666 B. T. U. available per pound of bagasse and $\frac{2666}{966} = 2.76$ pounds of water evaporated from and at 212,°. For 50% air excess per pound of bagasse substitute 4.3 for 2.93 in the above formula, which will give a loss through the stack of 1439 B. T. U., representing a loss of 35.1%; 2528 B. T. U. will be left for evaporation, and this will be 2.62 lbs. from and at 212° per pound of bagasse.

A similar calculation for 100% air excess shows a loss through the stock of 38.5%, and an equivalent evaporation from and at 212° of 2.48 pounds of water. Comparisons of the figures just obtained shows that for every increment of 50% air excess, there is an increase of loss through the stack of 3.5% and a decrease in evaporation of .14 lbs. of water per lb. of bagasse. See Fig. 3 and Table A. In Table A will be found data relating to bagasse, etc., the different items of which were calculated as explained on preceding pages.

TABLE A.

		Total Solids				Heat Absorbed by the Dry Gases of Combustion B. T. U.			Available Heat for Evaporation Allowing 5 per cent for Radiation B. T. U.			Lbs. of Bagasse required to equal One Lb. of Coal of 14000 B.T.U. Calorific Value			Lbs. of Bagasse required to equal One Gallon of Fuel Oil of 0.915 sp. gr. and 19,000 B.T.U. Calorific val. 1 Gal. of above Oil equal 7.62 Lbs.			Lbs. of Water capable of being evaporated from and at 212° F.			Theoretical Furnace Temperature		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Per Cent Extraction on Weight of Cane	Per Cent of Moisture in Bagasse	Per Cent of Fiber in Bagasse	Per Cent of Sugars and Non-Sugars in Bagasse	The total heat value of one lb. of the Bagasse, B. T. U.	Heat Absorbed by the Free Moisture and Moisture of Formation	No excess air	50 per cent excess air	100 per cent excess air	No excess air	50 per cent excess air	100 per cent excess air	No excess air	50 per cent excess air	100 per cent excess air	No excess air	50 per cent excess air	100 per cent excess air	No excess air	50 per cent excess air	100 per cent excess air	No excess air	50 per cent excess air	100 per cent excess air
The value of one pound of unmacerated milled Bagasse at different extractions upon cane of 10% fiber, and juice of 15% total solids. Representating La. conditions. Assuming 80° F. fire room and 500° F. stack temperature.																							
70	56.7	33.3	10.0	3626	1023	276	403	530	2209	2090	1970	6.34	6.70	7.11	65.5	69.2	73.5	2.29	2.16	2.04	2722	2150	1800
75	51.0	40.0	9.0	4100	986	308	453	594	2666	2528	2394	5.25	5.54	5.85	54.4	57.3	60.5	2.76	2.62	2.48	3038	2360	1943
80	42.8	50.0	7.5	4816	936	359	528	694	3345	3184	3027	4.18	4.40	4.62	43.2	45.4	47.8	3.46	3.30	3.13	3443	2602	2140
The value of one pound of unmacerated milled Bagasse at different extractions upon cane of 12% fiber and juice of 18% total solids. Representing tropical conditions. Assuming 80° F. fire room and 500° F. stack temperature.																							
70	49.2	40.0	10.8	4254	986	318	466	610	2792	2662	2525	5.02	5.26	5.54	51.8	54.3	57.3	2.89	2.76	2.62	3118	2430	1987
75	42.6	48.0	9.4	4807	936	360	530	694	3335	3174	3018	4.20	4.41	4.64	43.4	45.6	48.0	3.45	3.28	3.12	3436	2600	2135
80	32.8	60.0	7.2	5628	886	435	630	833	4092	3906	3713	3.42	3.59	3.78	35.4	37.0	39.0	4.24	4.05	3.48	3702	2782	2253

SCOPE OF EXPERIMENTS.

In view of the principles discussed above, experiments were planned for the purpose of studying the characteristics of bagasse as a fuel, as well as the appliances used for its combustion and the utilization of its heat. Furnaces representing the different types were selected and, through the co-operation of the owners, tests were made. The observations were such as to facilitate the study of the fuel itself and all the conditions affecting its combustion, such as weight of bagasse fed to the furnace, moisture, fiber, sucrose, ash and calorific value of the bagasse; grate surface; heating surface; ratio of heating surface to grate surface; total boiler horse power per ton of cane per 24 hours; bagasse boiler horse power per ton of cane per 24 hours; diameter and height of stack; dimensions of furnace; draft and temperature in the furnace; draft, temperature and composition of the flue gases; volume of air supplied to the furnace by blower and through draft doors; the excess of air, etc.

With a view of studying the effects produced by the various methods used by firemen in manipulating furnaces, other experiments were also made, in which the air supply was varied by means of the stack damper, the fire doors and the speed of the blower; the effects being shown in the furnace temperature, stack and furnace draft, flue gas composition, etc. It will be noted that the above does not include the measurement of the feed water. In other words, the evaporative test, with one exception only, was not used in these investigations. The original plan did not include this kind of test, but it was decided that as the evaporative tests, on account of the difficulties and expense attached, would render it impossible to make more than a few tests and this, in turn, making it impossible to gain the general knowledge of conditions which was thought to be of prime importance at this stage of the investigations.

The tests may therefore be regarded as "furnace tests." However, it was thought advisable to make one evaporative boiler test.

EVAPORATIVE BOILER TEST.

The object of this test was to gather some data as to the evaporative value of bagasse to be used later in the study of the furnace tests. This test was conducted according to the rules formulated for boiler trials by the American Society of Mechanical Engineers. The cane was weighed and the volume of the juice was measured in the juice tanks. By observing the density of the juice, its weight was calculated and this subtracted from the weight of the cane gave the weight of the bagasse leaving the mill. The feed water was measured in two sugar wagons holding a known weight, from which it was drawn alternately by the feed pumps. The per cent moisture in the bagasse was obtained in the manner already described for the furnace tests. The instruments used were all correct or corrected by comparing with ones that were known to be correct. Observations of the temperature of the feed water, flue gas, and furnace; draft in furnace and stack and pressure of air in blower discharge pipe; pressure in boiler and flue gas samples were taken every 20 minutes throughout the test, which was of 11.5 hours duration. The observations were taken by Mr. E. M. Percy and four graduate and senior students in the engineering courses at the Louisiana State University, under the supervision of the writer.

The boiler tested is that described as A_1, under furnaces, being a 318 rated H. P. Stirling boiler. Every precaution was taken to insure that the blow-off valve and the feed pipe connections did not leak. As there was no opportunity to connect a steam calorimeter to the steam main, which had steam in it, the quality of the steam was assumed as .98, or .02 moisture. The boiler tubes had been blown off with steam a few hours before the test.

The total ash and refuse was obtained by starting the test with a clean ash pit and weighing the ashes, clinker, etc., at the end. The ash and refuse in the dry bagasse (item 7) was derived from the above by calculation. Item 11 (factor of evaporation) was obtained by dividing B. T. U. required to convert a pound of water at the feed water temperature of 79° into dry steam at the observed pressure of 97.8 lb. gage, corresponding to a temperature of 336°, by the B. T. U. required to convert a pound of water at 212° into dry steam at 212° (from and at 212°). This may be expressed

$$\frac{1184.5-(79-32)}{965.8}=1.1774$$

in which 1184.5 is the total heat in a pound of steam at 97.8 lb. gage and 965.8 is the latent heat at 212°F. Item 10 is item 9 × 1.1774. Item 9 is .98 of item 8. The gross calorific value of a pound of dry bagasse was determined by means of a calorimeter and the net value calculated from it in the manner described on page 14.

The efficiency of any machine is the ratio of energy it converts into useful work divided by that supplied. In the case of a boiler it is the ratio of the heat utilized in vaporizing the water divided by the heat in the fuel. As shown by the test, there was an equivalent evaporation of 2.26 pounds of water per pound of fuel, and the net value of one pound of bagasse was 3256 B. T. U. The efficiency will therefore be

$$\frac{2.26 \times 965.8}{3256}=67\%$$

Following will be found averages of observations and calculated results:

RESULTS OF EVAPORATION TEST.

Fuel used, bagasse.

Furnace, Stirling, with bottle neck.

Two grates, 5'x5'; grate surface, sq. ft.	50
Water heating surface, sq. ft.	3,188
Ratio of heating to grate surface	63.6
Height of stack, feet	112
Diameter of stack, 48"; area in sq. ft.	12.5

TOTAL QUANTITIES.

1. Date of trial	Nov. 24, '08
2. Duration of trial, hours	11.5
3. Weight of bagasse as fired, lbs.	69,200
4. Per cent of moisture in bagasse	52.1
5. Total weight of dry bagasse, lbs.	33,147
6. Total ash and refuse, lbs.	754.4

7.	Per cent of ash and refuse in dry bagasse	2.27
8.	Total weight of water fed to boiler, lbs	136,760
9.	Water actually evaporated (quality .98), lbs	132,835
10.	Equivalent evaporation—dry steam, from and at 212°, lbs	156,400
11.	Factor of evaporation	1.1774
12.	Per cent ash in bagasse, as fired	1.09

HOURLY QUANTITIES.

13.	Bagasse consumed per hour, lbs	6,017
14.	Dry bagasse consumed per hour, lbs	2,882
15.	Bagasse per sq. ft. grate surface per hour, lbs	121
16.	Dry bagasse per sq. ft. grate surface per hour, lbs	58
17.	Water evaporated per hour into dry steam, lbs	11,551.0
18.	Equivalent evaporation, from and at 212° per hour, pounds	13,600.0
19.	Equivalent evaporation from and at 212° per sq. ft. of heating surface, per hour	4.27

AVERAGE PRESSURE, TEMPERATURE, ETC.

20.	Steam pressure, gage	97.8
21.	Temperature of feed water, degrees F	79
22.	Temperature of flue gases, degrees F	594
23.	Temperature of furnace, degrees F	1200
24.	Flue draft, inches of water	.87
25.	Furnace draft, inches of water	.07
26.	Quality of steam, per cent dry	98

Horse Power.

27.	H. P. developed (item 18 ÷ 34.5)	394.2
28.	Builders' rated H. P.	318.0
29.	Per cent of builders' rated H. P. developed	124

Economic Results.

30.	Apparent evaporation—actual conditions—per lb. bagasse as fired	1.97
31.	Equivalent evaporation from and at 212° per lb. bagasse as fired	2.26
32.	Equivalent evaporation from and at 212° per lb. of dry bagasse	4.7

33. Per cent CO_2 in flue gases	11.3
34. Per cent O in flue gases	8.1
35. Per cent CO in flue gases	0.23
36. Excess air, per cent	71
37. Net calorific value of wet bagasse, per pound, B. T. U.	3256
38. Efficiency, per cent	67.0

DISCUSSION OF THE RESULTS FROM EVAPORATION TEST.

Naturally, the item of most interest is the "Equivalent evaporation from and at 212° per pound of bagasse fired, item 31, which is 2.26 pounds, or 4.7 lbs. per pound of dry bagasse. This does not differ materially from tests made in the past by other parties. Mr. Pharr made a test in 1896, in which 2.46 pounds of water were evaporated from and at 212° per pound of bagasse as fired. This is a larger evaporation than that in the test being discussed, but this may be accounted for in large part by the fact that in his test there was only 42.2 per cent moisture in the bagasse, while in this one there was 52.1 per cent moisture.

It should be noted that in this test there was an overload of 24 per cent (item 29), based on the builders' rating. This condition of overload may be seen also in the fact that 4.27 pounds of water were evaporated from and at 212° per square foot of heating surface per hour, whereas, as discussed on preceding pages, an equivalent of evaporation of about 3 pounds per sq. ft. per hour is taken to be normal. According to this, there was an overload of $\frac{4.27-3}{3} \times 100 = 42\%$. The temperature of the flue gases, which was an average of 594°, corroborates the other evidences just named, of an overloaded heating surface; in fact, it is about 100° higher than that which good practice calls for. According to the results of Mr. Barrus' tests, an increase of 6 per cent in the evaporation per pound of bagasse may be expected with a decrease of 100° in stack temperature. In the present case, therefore, by decreasing the stack temperature to 494° the equivalent evaporation should become $2.26 \times 1.06 = 2.39$ pounds. In other words, with the changed condition, the fuel supplied (6017 pounds per hour) would be increased by the amount, $6017 \times 24 \times .06 = 8664$ pounds per day of 24 hours, or $8664 \times 100 = 866{,}400$ pounds per season. Assuming that 45 pounds of bagasse (see Table A) are equivalent, in heat value, to 1 gallon of fuel oil, we have $\frac{866{,}400}{45} = 19{,}033$ gallons of oil thus saved per season. The figures given above are for 300 tons daily capacity, so that for a 1000-ton plant the saving would be $\frac{19{,}033 \times 1000}{300} = 63{,}443$ gallons of oil. With oil at $1.00 per barrel, the equivalent of money saved would be $\frac{63{,}443}{42} \times 1.00 = \$1510.00$.

The question naturally arises, how is this decrease in stack temperature to be brought about? The figures showing that the plant is evaporating above the normal quantity of water suggest at once the advisability of increasing the amount of heating surface, which means an increase in boiler capacity. By this means the same amount of bagasse, generating the same quantity of heat, would evaporate more water because less of the heat would pass up the stack. In this connection it will be well to notice that the average furnace temperature was 1200° F. It may be said, however, that the temperature was often much higher than this average, often going as high as 1500°, and a few times as high as 1600°; in other words, when the furnace was clean and doing its best, the temperature was usually 1400° to 1500°. However, it is best to consider the results obtained in the light of the average 1200°, and the average excess of air, which was 71%, the latter varying from a maximum of 124 per cent to a minimum of 47 per cent. It would seem that this furnace temperature was not so high as it should be for efficient heat transmission, and that steps to increase it would be proper. This could be done only by decreasing the excess of air, or, in other words, increase the rate of combustion, which in the test was 121 pounds of bagasse per square foot of grate per hour. As the combustion seemed to be as rapid as was possible under the existing conditions, it would be necessary to run the blower at a higher speed, increase the size of the blower, or decrease the area of the grate, the latter being the most practicable plan, in the opinion of the writer. In case the boiler capacity were increased as suggested above, causing a smaller quantity of bagasse to be burned on each grate, it is evident that each of the grates should be decreased in size in order that the total grate surface of the plant will be not more than before the change; otherwise the rate of combustion will be decreased below that which existed before the change, and this is exactly the opposite of what seems to be best. In other words it would seem best to make the grate as small as possible in any case, as the resulting intensity of heat will increase the efficiency of heat transmission. As will be shown later under furnace tests, rates of combustion as high as 150 pounds of bagasse per square foot of grate surface in Louisiana and 170 pounds in Cuba were found to be easily carried.

In coal furnaces, the general practice seems to take 100% air excess as the approximate quantity of air required to insure complete combustion. In bagasse furnaces, however, there seems to be less need for air excess on account of the great amount of air contained in the bagasse itself. In the tests carried on we have rarely found the air supply inadequate enough to cause the production of CO in the flue gas. The 71% excess of air in this test therefore seems higher than necessary, which is another argument in favor of a greater rate of combustion for this furnace.

TESTS OF FURNACES.

It may be stated that the principal objects of the furnace tests were to observe the performance of furnaces with varying proportions, varying rates of combustion and varying air supply.

It was therefore necessary to carefully measure the dimensions of the boiler as well as the furnace. The rate of combustion (pounds of bagasse per square foot of grate surface per hour) was determined by dividing the weight of bagasse feed to the furnace per hour by the area of the grate in square feet. The weight of bagasse per hour was determined by weighing the cane fed to the mill and subtracting from it the weight of juice expressed.

METHODS USED IN CONDUCTING THE TESTS.

Expert labor and chemical control, where employed, proved of great assistance in this work. For instance, in all the modern factories, such items as capacity in tons per 24 hours; extraction and the per cent. of fiber, moisture and sugar were taken from the records of the chemical laboratory. Otherwise these items were determined in the following manner: For eight or ten hours the cane was weighed previously to being put on the carrier; the volume and degree Brix of the juice extracted from this weighed cane was observed and from this the weight of extracted juice was calculated. The weight of juuice divided by the weight of cane and multiplied by 100 gave the per cent. extraction.

As the bagasse issued from the last mill, 40 to 50-pound samples were collected, put in three or four light sacks, and placed on top of the boilers where they were dried for 24 hours or more. From the initial and final weights the per cent. moisture was calculated.

Stack temperatures were observed by means of a 700 deg. Fahrenheit thermometer. A ⅜-in. iron pipe, filled with cylinder oil was placed in the stack at an incline and the thermometer inserted and allowed to remain. The object of the oil was to reduce fluctuations of temperature and breakage due to sudden blasts. Stack draft was determined by means of a U tube manometer. This instrument is a small glass tube, preferably about ¼-in. diameter, bent into the shape of

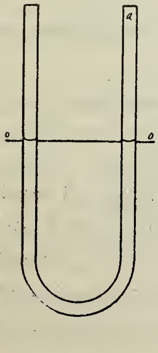


Fig. 4.

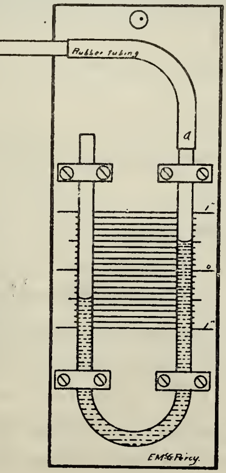


Fig. 5.

the letter U, figs. 4 and 5. The tube is mounted on a block of wood and a scale graduated to tenths of an inch is fitted to the block just back of the tube. The tube is filled with water until the bottom of the maniscus, or curve of the water, stands at zero. At the top of either leg, as at "a," a rubber tube of convenient length is attached. To the other end of the rubber tube a metallic or glass tube of sufficient length to project some distance into the stack is attached. Fig. 5 illustrates the instrument in operation. Since the stack gases are of a high temperature and therefore greatly rarefied, there is less pressure existing within the stack than in the surrounding atmosphere. The extent of this difference is measured by the displacement of water in the two legs of the tube. As may be noticed in Figure 5 the water stands half an inch above and half an inch below the zero mark, which makes a total difference of 1 inch. This is known as a "draft of 1-in. of water." Draft is sometimes expressed in ounces per sq. inch. 1-in. of water is equivalent to 0.577 ounces per sq. in., so the two may be converted one into the other as desired.

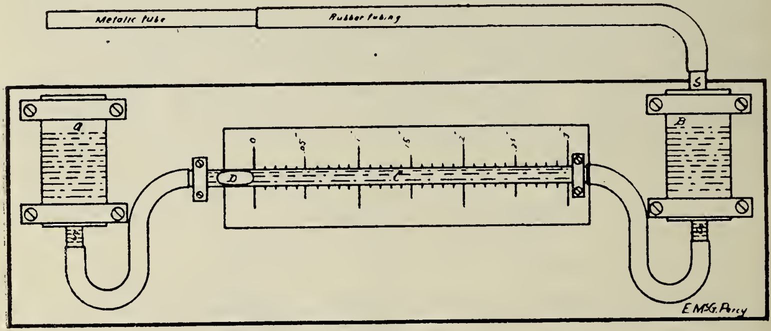


Fig. 6.

Fig. 6 shows the form of the instrument devised for measuring the draft in the furnace. It is a modification of the U tube manometer and operates as follows: A and B are glass tubes of the same bore, one inch diameter by 3 inches in length. These are corked at each end and fitted with small glass tubes, S. The glass tube C is ¼-in. bore and about 6 inches long. The bubble D is obtained by inclining the instrument until it is entrapped. The draft causes a rise of the water in B and a fall in A. As the draft in the furnace is very small, usually less than 0.1-in., this difference in water levels could not be read accurately, hence the necessity for some device as C for magnifying the reading. The extent to which the movement of the bubble in C magnifies the reading is governed by the ratio of the cross section areas of A and C. Take A with an inside diameter = 1’’ which gives an area of .7854 sq. in. Take C with an inside diameter = ¼’’ which gives an area of .049 sq. in. Then .7854 : .049 : : x : 1 and x = 16. That is, a difference of 1’’ levels in A and B will cause the bubble to move 16 inches. A scale graduated to hundredths of an inch is mounted on the block back of C. The stack draft was observed at the base of the stack through a small hole made for the purpose, while the furnace draft was usually taken at the fire door through the damper.

Furnace temperatures were taken in most cases just behind the bridge wall with a Bristol Portable Electric Pyrometer, Fig. 7. This instrument consists of an indicator graduated to read as high as 3000 deg. F.; seven feet of fire end; and fifteen feet of leads, all of which are detachable. The indicator is a milli-volt meter graduated in degrees instead of volts. The fire end consists of a compound-thermo electric couple terminating in a short platinum rhodium couple from which a voltage proportional to the temperature is induced. The electric couple is protected by a covering of special fireproof insulation of asbestos and carborundum. This insulated couple is in turn protected by enclosing it in a ⅜’’ iron pipe closed at one end, so that nothing except the platinum-rhodium couple is exposed to the furnace heat.

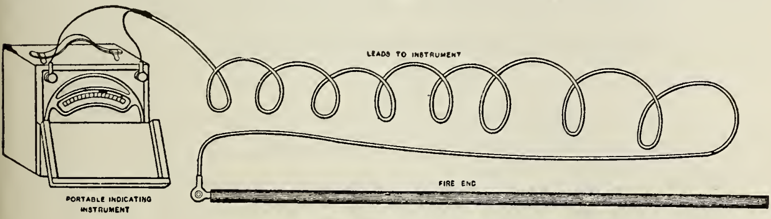


Fig. 7.

For the flue gas analysis an Orsat apparatus was used. The sample was extracted from the stack by collecting over water with the aid of two sampling cans. From this sample 100 cubic centimeters are drawn into the graduated burette of the instrument and forced in succession through three bottles containing potassium hydroxide, pyrogalic acid and cuprous chloride, which absorb respectively the carbon dioxide, the oxygen and the carbon monoxide.

The decrease in volume at each operation, due to the absorption, is measured in the burette.

The samples of gas, in these tests, were taken from the stack when the boiler setting and smokebox were found to be without cracks or other openings, otherwise they were taken at the back of the boiler setting so as to insure that the samples were representative of the products of the furnace only.

To determine the volume of air delivered to the furnace by the blower, the velocity of the air in the discharge pipe of the blower in feet per minute was determined and this multiplied by the cross section area of the pipe gave the volume in cubic feet per minute. The velocity was obtained by means of a Pitot tube, shown in fig. 9, which operates as follows:

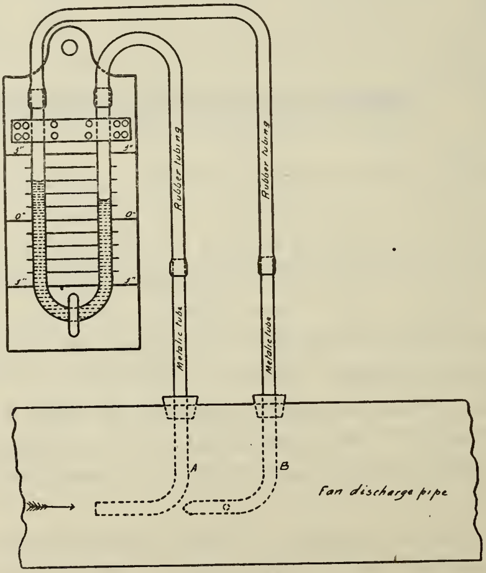


Fig. 9.

A and B are two brass tubes. A is open and of the same bore throughout. At the end it is beveled, on the outside, to a sharp edge in order to prevent eddies or similar air currents. The bend "A" forms a right angle and the open end is so placed in the discharge pipe as to directly face the current of air. B is bent and set in the same manner as A, but the end is closed and tapered to a point. About half-way between the point and the bent, a very small clean-cut hole is drilled in the side. As shown. a U-tube is connected to these tubes. The pressure in the leg connected to A will be that due to the static pressure plus that due to the velocity of the air. The pressure in the leg connected to B will be that due to the static pressure only. Since the two tubes are connected to the two legs of the same U-tube, the two pressures will oppose each other. The static pressure in each case will counterbalance so that the difference in water level in the U-tube is due only to the velocity and is known as the velocity head.

The velocity head having been determined, the velocity is determined by the formula $V = c\sqrt{2\ g\ h}$, in which V = velocity in feet per second; c a constant which may be taken as unity; g a constant = 32.2 and h the height in feet of a column of air equivalent to the head of water (velocity head) shown in the tube. The ratio of air head to water head would depend upon the temperature of the air and water. For a temperature of 80° F. the weight of a cu. foot of air is .073 lbs. and of water is 62.4 lbs., so that the ratio would in that case be $\frac{62.4}{.073} = 856$.

The formula would become, for this condition, $V = c\sqrt{2 \times 32.2 \times 856\ H} = 742\ \sqrt{H}$ in which H is the height of water in the U-tube, in feet.

The calorific value of the bagasse was determined by a Mahler-Khraeger bomb calorimeter of the latest design. Average samples of the fuel were obtained by selection from a large quantity and preserved in a sealed jar until they could be attended to in the laboratory. The laboratory work on the fuel consisted in determining the heat value and the ash. As is well known, an increase in the percentage of ash in a fuel will cause a corresponding decrease in the heat value.

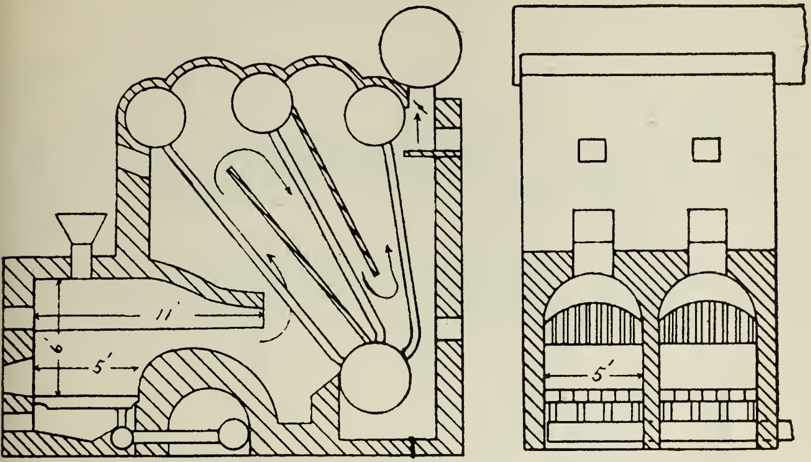
DESCRIPTION OF THE FURNACES TESTED.

All the furnaces tested belong to the three classes already referred to, viz: the dutch oven, the ordinary, the hearth, or combinations of one or more of these. There were in reality 35 different furnaces, representing 19 different constructions, no two of which were alike, the differences in any one type being brought about by variations of the length, size, form and location of the combustion chamber; the slope and height of the bridge wall; the type and arrangement of grate bars; the system of applying or obtaining draft; by changes in furnace division walls; system of feeding the bagasse, etc.

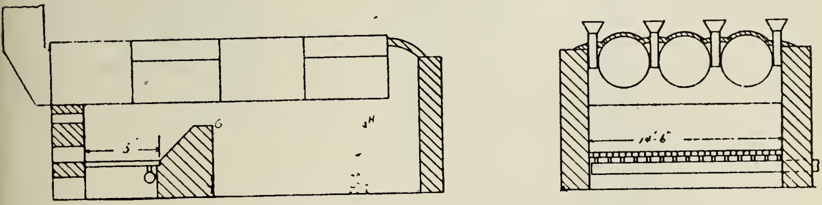
In the following furnace descriptions very little or no mention is made of grate area, size and shape of combustion chambers, and, in fact, anything that is self-evident from the drawings. For a description of the boilers used in conjunction with each of these furnaces see Table III. For other information on this subject see Tables I and V.

In these tables each factory is designated by a capital letter, A, B, etc. In some factories tests were made on two or more furnaces of different types, each of which is designated in the table by a subscript 1, 2, 3, etc. For instance, at factory G, tests were made on three furnaces which are designated G_1, G_2 and G_3. Sketches of the different constructions are given herewith.

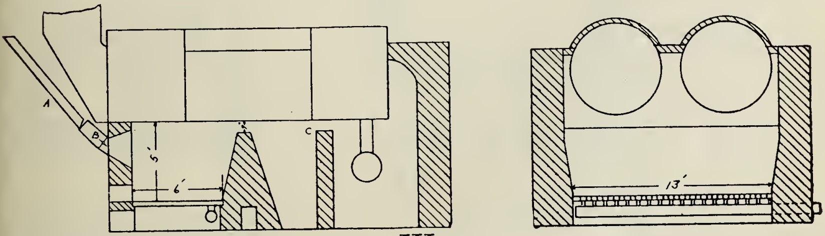
These sketches are not to be regarded as more than approximately accurate. They are given mainly for the purpose of showing forms and types. In some of them the mud drums have been omitted.



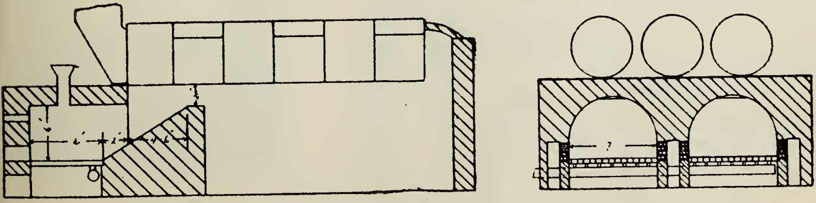
I



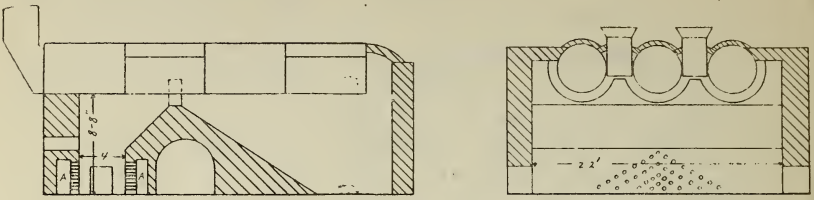
II



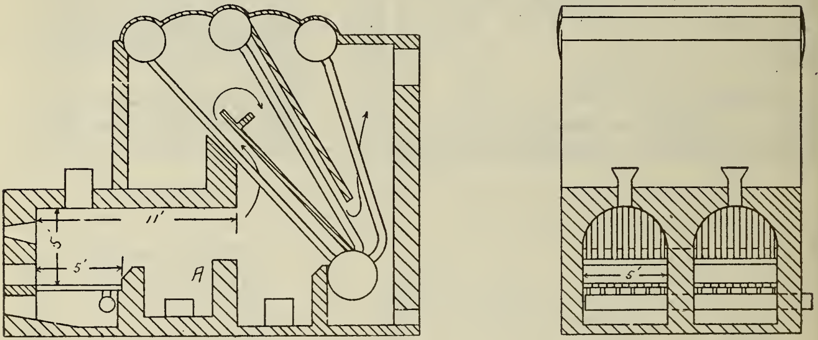
III



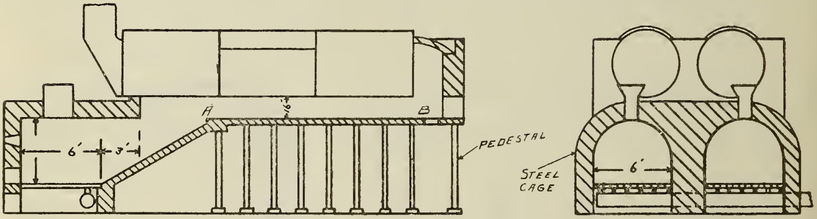
IV



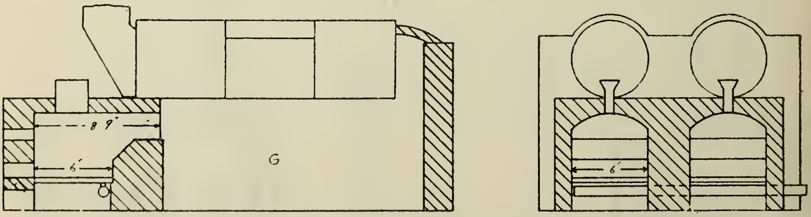
V



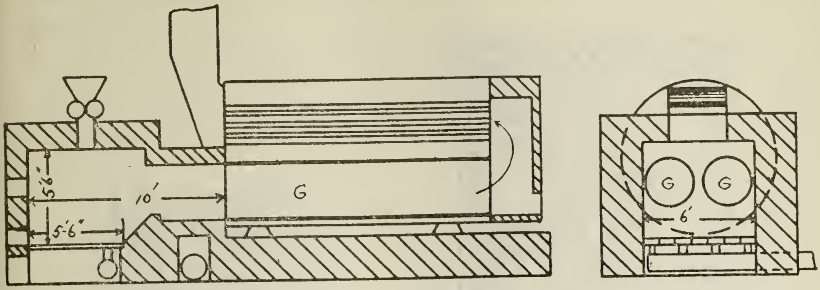
VI



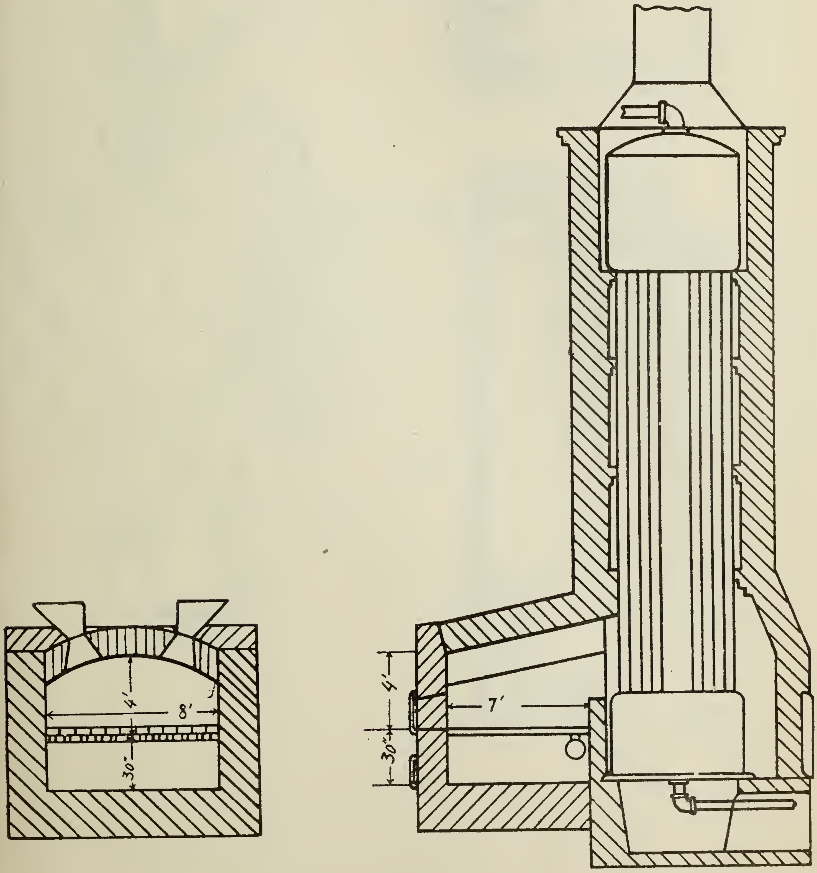
VII



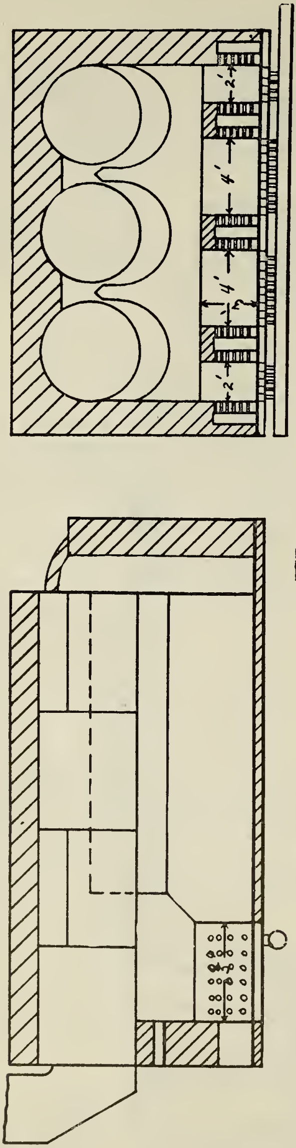
VIII



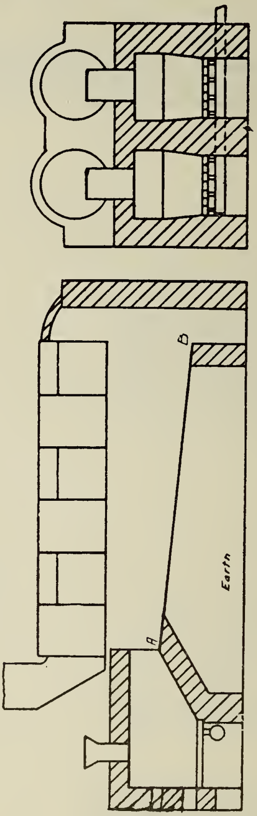
IX



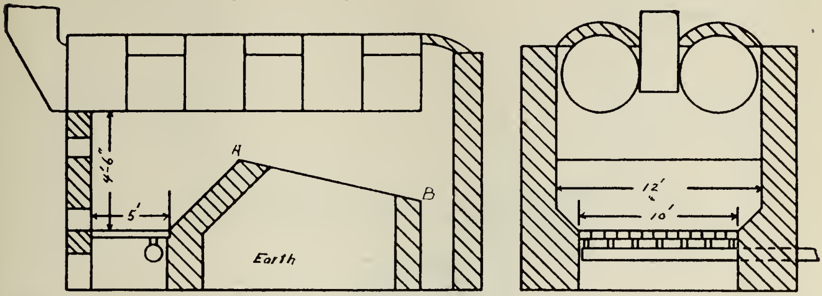
X



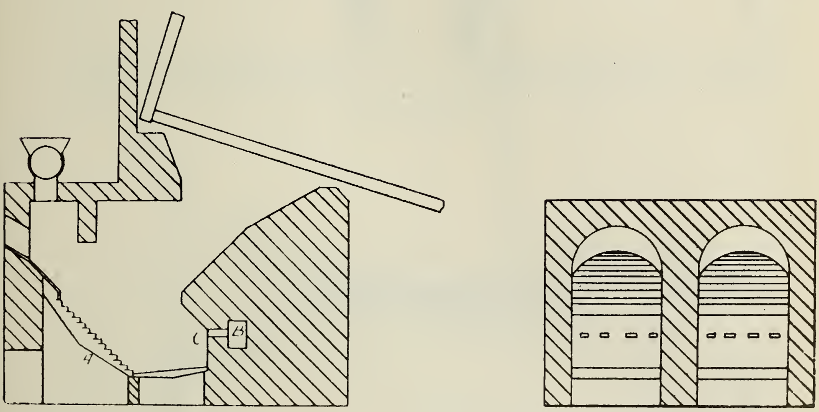
XI



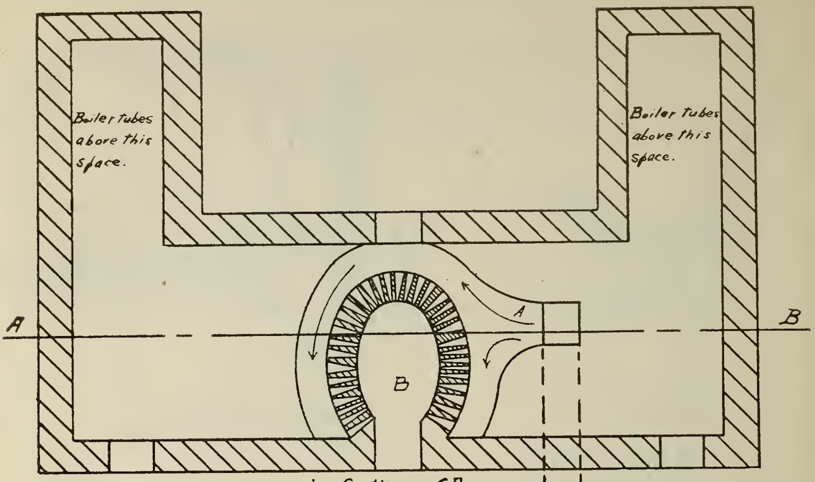
XII



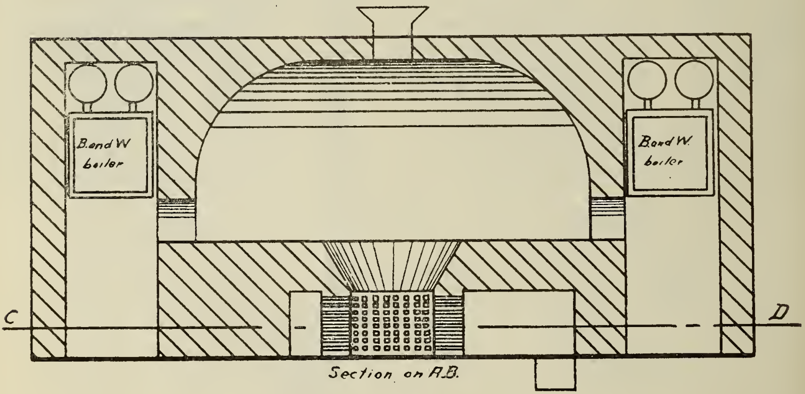
XIII



XIV

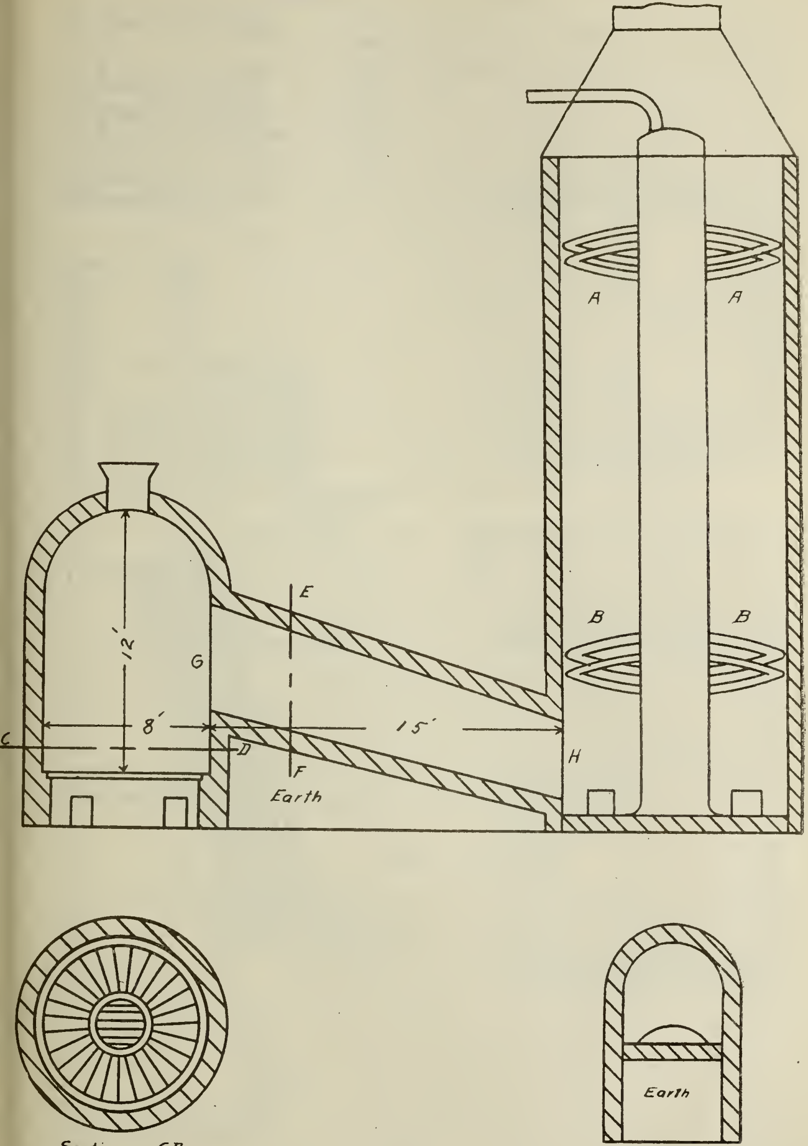

Boiler tubes above this space.
Boiler tubes above this space.
A
B
A
B

Section on CD.



Section on AB.

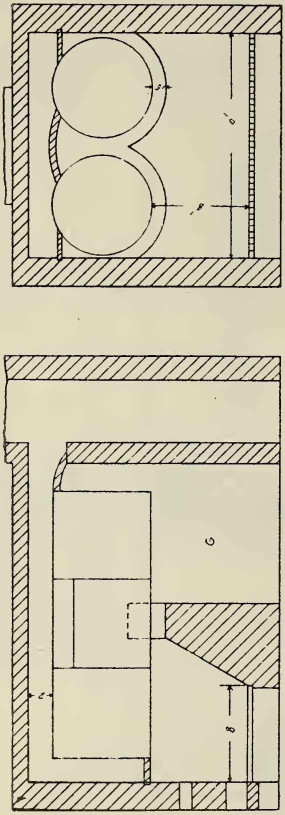
XV



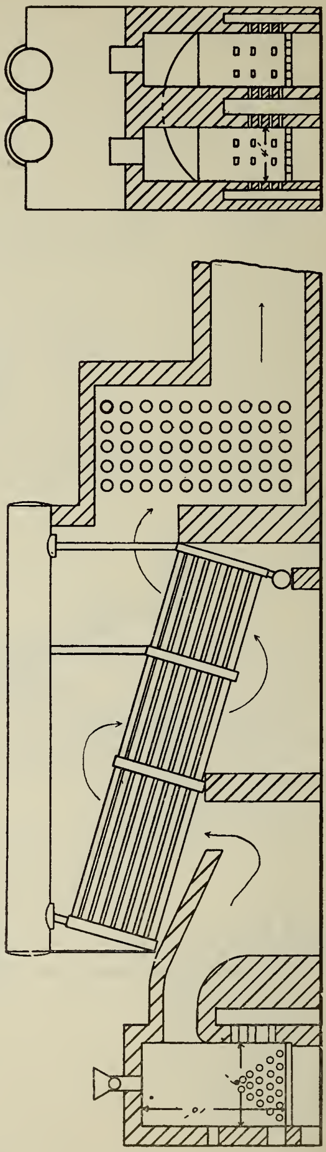
Section on CD

Section on EF

XVI



XVII



XVIII

FURNACE A_1—FIG. I.

This furnace is of the dutch-oven type built by the Sterling Boiler Co. Its principal characteristic is that its combustion chamber converges, somewhat like a bottle-neck, leading from the bridgewall toward the boiler. Forced draft is obtained by a blower belted to an engine the speed of which could be varied. Air is delivered to the furnace through Gordon hollow-blast grate bars, which alternate with herring-bone grate bars. The fan discharge pipe, leading to the furnace is fitted with slide gates, and the flue to the stack with a damper. Bagasse is fed from a drag carrier running above the hoppers. Over each hopper is an opening, the size of which is controlled by a slide which regulates by hand the amount of bagasse delivered. The hoppers are fitted with weighted flap-doors which open automatically with the necessary weight of bagasse which is discharged into the furnace. By this arrangement much air is excluded.

FURNACE B_1—FIG. II.

In this construction there are no division walls between the boilers of a battery and the furnace is placed directly under the front end of the boilers. The bagasse is fed through four hoppers which are located as shown in the figure. The method of obtaining forced draft, the arrangement of grate bars, and the method of feeding bagasse to the furnace are similar to those described in A_1, except that there was no gate in the discharge from the blower with which to control the air supply.

C_1—FIG. III.

This furnace has no division wall. The method of obtaining forced draft and the arrangement of grate bars is similar to that described for A_1. The furnace is fed by the Fisher bagasse distributer. This distributer consists of a shute (A), the entire width of the furnace, at the bottom of which is a shaft (B) fitted with cross-arms which revolves rapidly, thereby scattering the bagasse over the surface of the grate. The flue is fitted with a damper and the furnace with oil burners which are used only when necessary to keep up steam. Frequently steam only was allowed to flow through the oil burners for the purpose of burning down the bagasse when it was piled too high.

D_1—FIG. IV.

Dutch oven type. This furnace has a hollow division wall. Natural draft is used, but it is equipped with hollow blast bars and tuyeres in its side walls for the purpose of using forced draft. The blower blast pipes are fitted with gates which permits draft to be obtained in four different ways—namely, natural draft, forced draft through the hollow blast bars alone, forced draft through the tuyeres alone and a combination forced draft through both. The furnace is fed as in A_1. During the tests chimney draft only was used.

E—FIG. V.

The hearth type, known as the Dunn & Sutcliffe furnace. Bagasse is delivered to the furnace by the scraper carrier described heretofore and fed to the furnace through two hoppers which enter between the boilers. There is no grate and the bagasse falls in two heaps on a fire brick floor at the ground level. Forced draft is applied through 84 tuyeres, 42 in the front wall and 42 in the bridge wall, the air being supplied to the chambers (A) by a blower. There are doors at each end of the furnace through which it is cleaned every few hours.

F_1—FIG. VIII.

Dutch oven type. Forced draft is delivered through hollow blast grate bars alternating with herring-bone bars. Bagasse is delivered by a drag carrier to two counterweighted door hoppers. The hoppers dump too near the fire doors and the bagasse piles against the front wall. This furnace is fitted with oil burners and they are in operation most of the time, chiefly to keep down the bagasse which tends to accumulate faster than it can be burned. When the oil is off the steam jet of the burner is left on in order to blow and burn the bagasse away from the front wall.

G_1—FIG VI.

Dutch oven type. This furnace is built by the Stirling Co. and is known as their "full dutch oven" type. The forced draft system and furnace feed are the same as in A_1. Oil burners are connected but are only used when necessary to keep up steam.

G_2—FIG I.

See description under A_1. Oil burners attached.

G_3—FIG. VII.

Dutch oven type. This furnace was built by the Casey & Hedges Boiler Co. The forced draft, bagasse feed and hoppers are the same as in A_1. Oil burners used only when necessary to keep up steam pressure. That part of the combustion chamber back of the bridge wall is parallel to and unusually near the boiler itself. The entire brick setting is enclosed within a steel cage, which is supported at the back on iron pedestals.

H_1—FIG VII.

Same as G_3, except that it was built by J. H. Murphy & Co. Oil burner attached.

H_2—FIG. VIII.

Dutch oven type. The grate to this furnace extends back nine feet, which would throw the bridge wall farther back under the boiler than shown in Fig. VIII. Forced draft is delivered through J. H. M. hollow blast bars alternating with herringbone bars.

Oil burners are attached but used only when necessary to keep up steam.

I_1—FIG VI.

Sterling full dutch oven. Forced draft is delivered through Koch hollow blast bars alternating with skeleton bars affording a one-inch opening for natural draft. The furnace is fed as in A_1. Oil burners attached.

I_2—FIG. VI.

Dutch oven type. This furnace is built by the Sterling Co. and is known as their "half dutch oven" type. The oven is only 7 feet long instead of 11 feet, as in Fig. VI. Forced draft is delivered through 14 3-8 tuyeres, 7 tuyeres on each side. The grate is composed of skeleton bars only, affording a one-inch opening between bars. The furnace is fed as in A_1. Oil burners attached.

I_3—FIG. VI.

Sterling half dutch oven. The grate is composed of skeleton grate bars only, affording a ¾" opening between bars. A ¾" steam pipe leads from the boiler into the smokestack. The end in the smokestack is fitted with an elbow and nipple which is turned upward. This is used as a means of induced draft and is regulated by a valve in the line. This furnace has no blower. The furnace is fed as in A_1. No oil burners.

J_1—FIG. VIII.

Dutch oven type. This furnace is fitted with hollow blast bars alternating with herring-bone bars, but forced draft is used only when the grates become choked. The furnace is fed as in A_1.

K_1—FIG. III.

This furnace is fitted with a Fisher bagasse distributer. See description under C_1. Oil burners are attached but are used only when necessary to keep up steam.

L_1—FIG. XI.

This furnace is divided by hollow walls into a number of "retorts." Each retort is fed from one hopper, the bagasse dropping on the ground. Forced draft is delivered through tuyeres from the side walls. The hoppers are the flap-door automatic dumping type. Oil burners are only used when necessary. This furnace differs from that shown in Fig. XI in that there are no partition walls between boilers of the battery.

L_2—FIG II.

See description under B_1. Oil burners are used only when necessary.

M_1— FIG XI.

See description under L_1. There are tuyeres in the grate in addition to those in the side walls. The fan discharge pipe passes through the furnace back of the bridge wall which heats the air supplied. The bagasse is fed by inclined shutes from the front.

N_1—FIG. VIII.

See description under E_1. Oil burners used only when necessary to keep up steam.

O_1—FIG. IX.

Dutch oven type, built by the Continental Iron Works, to be used in conjunction with their internally fired tubular boilers using the Morison Suspension Furnace. Forced draft is delivered through the Whipple hollow blast bar. These bars permit of revolution, by which to clean, while in operation. The bagasse falls from the carrier to the hopper, from where it is fed between two rolls ½'' apart to the furnace, thus preventing inflow of air through hopper. Oil burners used only when necessary to keep up steam

P_1—FIG. X.

This furnace is of the Dutch oven type as applied to the Cook water tube boiler. The method of obtaining forced draft, the arrangement of grate bars and the method of feeding bagasse to the furnace is the same as in A_1. The furnace is fitted with oil burners which are used constantly, bagasse and oil being burned in the same furnace.

P_2—FIG. X.

See description under P_1.

P_3—FIG. XII.

Dutch oven type. The method of obtaining forced draft, the arrangement of grate bars and the method of feeding bagasse to the furnace are similar to that described in A_1. Fitted with oil burners which were used at all times, the bagasse and oil being burned together.

Q_1—FIG. XIII.

See description under B_1. Oil burners used when necessary to keep up steam.

R_1—FIG. XIV.

The Hawaiian type of ''step-grate'' furnace, built by the Honolulu Iron Works and applied to the Babcock and Wilcox boiler. The feed hopper is also made by the same firm. It consists of a revolving roll, having pockets in its circumference. These pockets fill with bagasse from above and discharge into the furnace as the roll turns. The flue is fitted with a damper which slides vertically. Natural draft only is used, the air passing into the furnace through the grate bars at A and through tuyeres C from the passage B, which is open at the ends.

R_2—FIG. XIV.

See description under R_1. Applied to a De Nayer boiler.

R_3—FIG. VI.

See description under G_1. Wood is used when necessary to keep up steam pressure.

R_4—FIG. XIV.

See description under P_1. Applied to a Stirling boiler.

S_1—FIG. XV.

The hearth type, known as the Cook furnace. This furnace has only been found in conjunction with the B. & W. boilers. The principal characteristic of this furnace is that the furnace proper is of the retort type and to the side instead of the front of the boiler and one furnace supplies two boilers. The flue gases from the back of the boiler pass under ground some 50 feet to the stack. The flues are fitted with dampers which slide vertically. Some wood is used when necessary to keep up steam. Air from a blower passes from the duct A through tuyeres to the retort B, into which the bagasse drops from above.

T_1—FIG. XVI.

Dutch open type. Applied to the Climax water tube boiler. Its principal characteristic is its shape and length of combustion chamber, which is self-explanatory in the sketch. Natural draft only is used. Pivoted dampers are used in the stack. Each boiler has its individual stack. Wood is burned in this furnace when the bagasse supply is insufficient.

U_1—FIG XVII.

The grates are 8 feet below the boiler. The combustion products pass under, return through and pass back over the top of the boiler of the stack. Wood is only used in case of a deficiency of bagasse, which is generally due to a stoppage of the cane mill. Natural draft is supplied by a chimney for each boiler. The bagasse is fed through inclined chutes from the front.

V_1—FIG. XV.

See description under S_1.

V_2—FIG XV.

See description under S_1.

V_3—FIG. XIV.

See description under R_1.

W_1—FIG. XVIII.

Dutch oven type. Forced draft is delivered through tuyeres in side walls and bridge wall. The flue gases pass from the back of the boiler under ground some 150 feet to the stack. In this passage is a device which heats the air before being delivered to the furnace. The hopper is fitted with a Honolulu Iron Works device as described under R_1. Wood is used when the bagasse supply is insufficient, though this seldom occurs except when the cane mill stops.

PREPARATIONS FOR TESTS.

As the experiments were made with the plants running as nearly as possible under normal conditions and as there were no measurements of the feed water, little preparation was required beyond placing the instruments. To do this, a hole about ¾" in diameter was cut in the stack in which to insert the stack thermometer and to get flue gas samples. Where there was a blower, holes were cut in the discharge pipe for inserting the pitot tubes (Fig. 9).

The pyrometer (Fig. 7) was inserted at a point such as would give the temperature at the back of the furnace, or, better still, just back of the bridge wall, where the temperature was most likely to be highest and constant. It was inserted, when possible, through a door at the side wall of the furnace. If there was no such door, it was inserted through the fire door, the instrument being long enough to reach to the back and top of the furnace. For either of these places a wooden door was made with a hole in it just large enough to accommodate the pyrometer, the outside diameter of which was about 1". Every time a reading was taken this temporary door was held in place by one assistant, while another inserted the instrument; in this way the conditions in the furnace being kept undisturbed. With only one exception was a hole cut through the brick wall of the furnace especially for the pyrometer.

OBSERVATIONS.

Everything being in readiness, the test was begun and a running log kept, consisting of the following observations taken every fifteen or twenty minutes throughout the test: draft at the base of the stack in inches of water, draft in the furnace in inches of water, pressure in discharge pipe of blower in inches of water, pressure in inches of water due to velocity of air in the blower discharge pipe, flue gas samples, flue gas analysis, furnace temperature, stack temperature, temperature of air in blower discharge, and boiler pressure. In case natural draft only was used the items temperature of air in blower discharge, pressure due to velocity of air and pressure of air (static) in blower discharge were omitted. Following are reproduced sample running logs from three furnaces, the first two being with forced draft and the last with natural draft only.

RUNNING LOG. TEST No. 14.

Number of reading	Time	Draft in stack, inches of water	Temp. in stack, degrees Fahr.	Draft in furnace, inches of water	Temp. in furnace, degrees Fahr.	Temp. of air in blower discharge	Pres. of air in blower discharge, inches of water	Pres. due to velocity of air in blower discharge	Boiler pres. gage	Flue-Gas Analysis		
										% CO₂	% O	% CO
1	2:00	0.5	600+	0.08	1400	76	3.2	0.9	95	11.0	8.0	0.0
2	2:30	0.5	600+	...	1350	...	3.1	0.9	92	12.0	7.0	0.0
3	3:00	0.5	600+	...	1225	75	3.1	0.9	93	11.0	8.2	0.0
4	3:30	0.5	600+	0.08	1250	...	3.2	0.9	95	11.0	9.0	0.0
5	4:00	0.5	600+	...	1350	74	3.1	0.9	97	...	...	...
6	4:30	0.5	600+	0.07	1350	...	3.1	0.9	90	12.0	7.2	0.0
7	5:00	0.5	600+	...	....	74	3.1	0.9	97	11.0	8.1	0.0
8	5:30	0.5	600+	...	....	...	3.2	0.9	100	....	...	...
9	6:30	0.5	600+	0.07	1200	73	3.2	0.9	102	....	...	...

REMARKS.—All flue gas samples taken from stacks. Breeching and setting in good condition and without leaks.

RUNNING LOG TEST No. 74.

No. of reading	Time	Stack draft, inches of water	Stack temp., Deg. F.	Furnace draft, inches of water	Furnace temp., degrees F.	Initial temp. of air in blower discharge	Final temp. of air in blower discharge	Pressure of air in supply to grate, inches of water	Boiler pressure	Flue-Gas Analysis		
										% CO₂	% O	% CO
	P. M.											
1	3:30	1.1	400	.08	1700	82	280	0.8	65	10.6	7.6	0.2
2	3:45	1.0	420	.02	1800	83	300	0.8	65	12.6	5.6	0.0
3	4:00	1.1	420	.08	1675	84	305	0.8	64	12.6	5.6	0.0
4	4:15	1.0	360	.17	1550	83	304	0.8	70	13.0	5.8	0.4
5	4:30	1.1	390	.16	1850	84	300	0.9	75	13.0	5.6	0.4
6	4:45	1.0	400	.09	1650	84	306	0.85	75	10.8	9.0	0.0
7	5:00	1.0	410	.16	1650	83	306	0.8	75	14.0	4.4	0.8
8	5:15	1.0	410	.16	1650	83	310	1.0	75	12.0	7.2	0.0
9	5:45	1.0	410	.05	1500	78	305	1.0	75	12.0	7.0	0.0
10	6:00	1.0	400	.06	1350	78	300	1.0	65	11.0	8.2	0.0
11	6:15	1.0	420	.06	1500	78	300	0.9	65	11.4	8.0	0.0

REMARKS:

Readings 1-5, damper closed 40%.
Readings 6-8, damper wide open.
Readings 9-11, damper closed about 60%.
Reading 4, with extra feed of bagasse.
Readings 9-11, with damper too close. Fire not good.

RUNNING LOG. TESTS 12 AND 13.

No. of reading	Time	Stack draft, inches of water	Stack temp., degrees Fahr.	Furnace draft, inches of water	Furnace temp., degrees Fahr.	Boiler pressure guage	% CO₂	% O	% CO
1	5:15	0.55	....	0.15	....	95	7.0	12.4	0.0
2	5:30	0.6	510	0.20	....	....	7.2	11.8	0.0
3	6:30	0.6	500	0.13	950 1000	95	7.4	13.0	0.0
4	7:30	0.6	500	0.22	....	....	5.6	14.4	0.0
5	8:30	0.6	500	0.14	900 1000	90	12.2	7.8	0.0
6	9:30	0.5	500	0.18	1300 1000	85	11.0	9.2	0.0
7	10:30	0.5	480	0.13	1450	87	10.0	10.0	0.0
8	10:40	....	480	0.2	1350	85	10.4	10.0	0.0

REMARKS:

Temperatures at top of line taken near back of furnace through feed hopper.

Temperatures at bottom of line taken 10 ft. back of bridge wall.

Breaching leaky at front of boiler. Natural draft.

Flue gas samples taken at back connection for tests 1-4 inclusive and at base of stack for others.

In addition to the running log, data was obtained upon the following variables: tons of cane ground per hour on the day of the test; extraction, per cent of cane; per cent moisture in bagasse; per cent sucrose in bagasse and per cent fiber in cane. This latter, as already stated, was obtained from the records of the chemical laboratory, or, if there was no chemical control, by methods previously described.

Besides the variables already named, the following factory data was obtained where possible: number, type, rated power, heating surface and dimensions of all boilers (bagasse and oil); dimensions of all grates; type and arrangements of grate bars; type and dimensions of bagasse furnaces; type, dimensions and number of chimneys; method of feeding bagasse to furnace, etc. The observations included in the running log were taken by four trained men. Of these, one collected the flue gas samples and analyzed them; another manipulated the pyrometer in determining furnace temperature, and the balance of the observations were distributed between the other two. The duration of the tests on a furnace varied, though in most cases it was in the neighborhood of four to six hours.

Tables I to V, inclusive, contain the observed and calculated data from all the tests. The items in Column 9 of Table II; Columns 8, 9, 10 and 12 of Table IV, and Columns 4, 5, 6, 9, 10, 11 and 14 of Table V are the averages taken directly from the running logs. Data from the chemical laboratory is found in Columns 2 and 3 of Table I and Columns 3 and 4 of Table II. General factory data, including dimensions, etc., are found in Columns 5, 6, 7, 10 and 11 of Table I; Column 3 of Table III; Columns 2, 3 and 4 of Table IV, and Column 4 of Table V. The items in Columns 8, 9, 12 and 13 of Table I; Columns 6, 7 and 8 of Table II; Columns 5, 6, 7, 11 and 13 of Table IV, and Columns 7, 8, 12 and 13 of Table V were calculated from the other data.

These different items are grouped as shown in the different tables so as to facilitate easy comparison, some of them being produced in more than one table. The running logs were not reproduced, as it was not thought their value would compensate for the large space they would occupy.

EXPLANATION OF THE TABLES AND THE METHODS USED IN CALCULATING.

In all cases, a factory is designated by a capital letter; a furnace by a capital letter with a subscript, and a test by numeral. For instance, we find in Table IV that there were tests of three different furnaces—I_1, I_2 and I_3 at Factory I. By reference to Table V we find also that tests 29 to 33, inclusive, were made on furnace I_1, test 34 was made on furnace I_2 and tests 35 to 37 were made on furnace I_3, the different tests on any one furnace being generally under different conditions.

The calculated items were found as follows:

Table I.—The items in Column 8 were determined by dividing the corresponding value in Column 7 by that in Column 2. The items in Column 9 = items in Column 5 ÷ items in Col. 2. The items in Col. 12 = items in Col. 10 ÷ items in Col. 11. The items in Col. 13 = items in Col. 2 less the total moisture divided by 24.

Table II.—The calorific value of a pound of dry bagasse was determined by means of a calorimeter as already explained. The

corresponding value (gross) for a pound of wet bagasse, Col. 6, and the net value for the same, Col. 7, also the loss due to moisture, were calculated as explained on page 14.

Table IV.—The pounds of bagasse burned per square foot of grate surface per hour, Col. 6, equals the total weight of bagasse per hour (Col. 13, Table I) divided by the total grate surface. The pounds of bagasse burned per square foot of heating surface, Col. 7, equals the total weight of bagasse per hour divided by the total heating surface. The per cent excess air, Col. 11, and air pressure in blower pipe, Col. 13, were determined as explained on pages 22 and 54, respectively.

Table V.—The items in Col. 7 are the same as in Col. 6 of Table IV. The cubic feet of air delivered by the blower per pound of dry bagasse was calculated according to the method given on page 57. The per cent ash, Col. 4, Table II, in the bagasse was determined in the chemical laboratory.

TABLE I.

1 Factory	2 Cane ground per 24 hours, tons	3 Extraction, per cent of cane	4 Location	5 Bagasse boiler horse power	6 Oil boiler horse power	7 Factory total boiler horse power	8 Ratio of total B. H. P. to tons of cane per 24 hours	9 Ratio of bagasse B. H. P. to tons of cane per 24 hours	10 Heating surface, bagasse boilers	11 Grate surface, bagasse boilers	12 Ratio heating surface to grate surface (bagasse)	13 Wt. of bagasse per hour, lbs.
A	300	76.5	Louisiana	319	264	583	1.94	1.06	3188	50	64	5880
B	220	74.8	"	128	......	128	0.58	0.58	1540	72	21	4584
C	525	74.0	"	600	200	800	1.52	1.14	6200	156	79	11750
D	350	72.0	"	300	300	600	1.72	0.85	3000	78	38	8160
E	500	71.0	"	200	500	700	1.40	0.40	2268	82	28	12080
F	585	75.0	"	700	300	......	......	1.2	7762	99	78	12187
G	800	74.0	"	700	500	1200	1.50	0.88	6600	232	28	17340
H	800	75.0	"	800	500	1300	1.62	1.00	8600	315	27	16600
I	1000	76.5	"	1060	500	1560	1.56	1.05	10600	223	46	19600
J	800	74.0	"	645	235	1080	1.35	0.80	7720	144	54	17340
K	1200	72.8	"	1500	......	1500	1.25	1.25	17600	444	40	27100
L	850	75.0	"	666	334	1000	1.18	0.79	9000	260	35	17920
M	1000	75.0	"	710	250	960	.96	0.71	8500	160	53	20900
N	2000	76.5	"	1000	700	1700	.85	0.50	12000	390	21	39200
O	1200	75.0	"	1000	1200	2200	1.83	0.85	9900	121	80	25000
P	1500	77.5	"	1376	600	1976	1.32	0.92	17520	464	38	28200
Q	1000	75.8	"	856	724	1580	1.56	0.85	10000	250	40	20200
R	1340	76.7	Cuba	3300	......	3300	2.46	2.46	35100	592	57	26000
S	850	75.9	"	2300	......	2300	2.70	2.70	17000	120	143	17060
T	1400	81.0	"	3000	......	3000	2.14	2.14	24000	140	172	23800
U	2400	80.0	"	3750	......	3750	1.56	1.56	45170	480	94	40000
V	4000	80.0	"	8800	......	8800	2.20	2.20	77000	340	226	67000
W	1350	72.7	"	2246	......	2247	1.67	1.67	22470	333	67	30800

TABLE II.

1	2	3	4	5	6	7	8	9
Factory	Variety of cane	Moisture in bagasse, per cent	Ash in bagasse, per cent	Heat value, B. T. U., of 1 lb. of dry bagasse, gross	Heat value, B. T. U., of 1 lb. of wet bagasse, gross	Net heat value of 1 lb. of wet bagasse, B. T. U.	B. T. U. loss due to moisture	Stack Temp., degrees Fahr.
A	Louisiana	53.0	1.19	8396	3940	3256	684	593
B	“	50.0	1.26	8431	4215	3556	659	650
C	“	50.0	1.11	8427	4213	3590	623	500
D	“	54.0	1.21	8340	3830	3157	673	500
E	“	54.0	-------	-------	-------	-------	------	------
F	“	53.5	-------	-------	-------	-------	------	------
G	“	52.0	.96	8350	4010	3334	676	625
H	“	52.8	1.40	8283	3910	3252	658	500
I	“	52.0	-------	-------	-------	-------	------	------
J	“	52.0	1.44	8357	4011	3336	675	600
K	“	55.5	-------	-------	-------	-------	------	------
L	“	54.0	-------	-------	-------	-------	------	------
M	“	52.0	-------	-------	-------	-------	------	------
N	“	54.1	.86	8318	3820	3144	676	625
O	“	50.0	-------	-------	-------	-------	------	------
P	“	54.3	.85	8409	3845	3186	659	650
Q	“	53.0	-------	-------	-------	-------	------	------
R	Cuba	52.3	.75	8431	4020	3369	651	500
S	“	51.0	.76	8400	4115	3504	611	400
T	“	52.0	.83	8435	4045	3349	696	704
U	“	52.0	.87	8650	4150	3502	648	500
V	“	53.0	.78	8300	3900	3283	617	376
W	“	51.0	.76	8380	4110	3494	616	423

TABLE III.

Factory	Furnace	Figure	DESCRIPTION OF FURNACE AND BOILER	Kind of Fuel Used
A	A_1	I	1 319 H. P. Stirling	bagasse
			6 H. R. T., 48″x24′. 2 12″ and 4 7″ flues	oil
B	B_1	II	3 H. R. T., 44″x24′. 2 10″ and 5 6½″ flues	bagasse
C	C_1	III	4 H. R. T., 72″x18′. 70 4″ tubes	bagasse
			200 H. P., H. R. T	oil
D	D_1	IV	3 H. R. T., 60″x24′. 20 6″ tubes	bagasse
			300 H. P., H. R. T	oil
E	E_1	V	3 H. R. T., 56″x28′. 3 15″ and 2 10″ flues	bagasse
			500 H. P., H. R. T	coal
F	F_1	VIII	2 H. R. T., 102″x22′. 122 5″ tubes	bagasse
G	G_1	VI	2 150 H. P. Stirling	bagasse
	G_2	I	1 200 H. P. Stirling	bagasse
	G_3	VI	2 H. R. T., 60″x22′. 20 5″ tubes	bagasse
			500 H. P. Stirling	oil

TABLE III—CONTINUED.

Factory	Furnace	Figure	DESCRIPTION OF FURNACE AND BOILER	Kind of Fuel Used
H	H_1	VII	2 H. R. T., 72″x18′. 70 4″ tubes	bagasse
	H_2	VIII	4 H. R. T., 60″x22′. 20 6″ tubes	bagasse
		VIII	2 H. R. T., 60″x18′. 44 4″ tubes	bagasse
			2 250 H. P. Scotch marine	oil
I	I_1	VI	1 500 H. P. Stirling	bagasse
	I_2	VI	1 290 H. P. Stirling	bagasse
	I_3	VI	1 290 H. P. Stirling	bagasse
			500 H. P. Stirling	oil
J	J_1	VIII	4 H. R. T., 72″x20′. 80 4″ tubes	bagasse
			3 H. R. T., 72″x18′. 80 4″ tubes	oil
K	K_1	III	12 125 H. P., H. R. T	bagasse and oil
L	L_1	II	3 H. R. T., 60″x18′. 44 4″ tubes	bagasse
	L_2	II	6 H. R. T., 54″x24′. 20 6″ tubes	bagasse
			3 H. R. T., 60″x18′. 44 4″ tubes	oil
M	M_1	II	7 100 H. P., H. R. T	bagasse
			3 120 H. P., H. R. T	oil
N	N_1	XIII	12 H. R. T., 60″x24′. 20 6″ tubes	bagasse
			6 H. R. T., 72″x16′. 80 4″ tubes	oil
O	O_1	IX	3 H. R. T., 11′x16′. 196 3½″ tubes	bagasse
			5 H. R. T., 72″x18′. 66 4″ tubes	oil
P	P_1	X	1 300 H. P. Cook	bagasse and oil
	P_2	X	4 250 H. P. Cook	bagasse and oil
	P_3	XII	6 H. R. T., 54″x24′. 14 6″ tubes	bagasse and oil
			2 150 H. P., H. R. T	oil
Q	Q_1	XIII	10 H. R. T., 60″x24′. 20 6″ tubes	bagasse
			725 H. P., H. R. T	oil
R	R_1	XIV	2 240 H. P. B. & W	bagasse
	R_2	XIV	2 260 H. P. DeNayer	bagasse
	R_3	VI	1 500 H. P. Stirling	bagasse
	R_4	XIV	4 500 H. P. Stirling	bagasse
S	S_1	XV	4 300 H. P. B. & W	bagasse
			2 250 H. P. B. & W	bagasse
			2 300 H. P. B. & W	coal or wood
T	T_1	XVI	4 600 H. P. Climax	bagasse
			1 600 H. P. Climax	wood
U	U_1	XVII	12 H. R. T., 8′x22′. 147 4″ tubes	bagasse
V	V_1	XV	10 550 H. P. B. & W	bagasse
	V_2	XV	2 550 H. P. B. & W	bagasse
	V_3	XIV	2 550 H. P. B. & W	bagasse
			2 550 H. P. B. & W	wood
W	W_1	XVIII	5 batteries of B. & W. Total H. P. 2247	bagasse

TABLE IV.

1	2	3	4	5	6	7	8	9	10	11	12	13
No. of furnace	Type of furnace	Grate surface, sq. ft.	Heating surface, sq. ft.	Ratio of H. S. to G. S.	Lbs. of bagasse burned per sq. ft. of G. S. per hour	Lbs. of bagasse burned per sq. ft. of H. S. per hour	Furnace draft, inches of water	Furnace Temp., degrees Fahr.	Stack Temp., degrees Fahr.	Per cent exces air	PRESSURE OF AIR IN BLOWER DISCHARGE	
											Inches of water	Ounces per sq. in.
	Figure											
A_1	I	50	3,188	64	121.0	1.84	.06	1,012	596	94	7.5	4.30
B_1	II	72	1,540	21	63	2.98	....	1,235	600+	45	1.25	.72
C_1	III	78	3,050	39	72	1.90	.07	1,095	506	122	10.	6.30
D_1	IV	78	3,000	38	105	2.72	.13	1,225	501	72	....	....
E_1	V	82	2,268	28	147	5.30	.07	1,300	600+	77	3.2	1.85
F_1	VIII	99	7,762	78	123	1.57	.03	1,500	600+	102	2.7	1.55
G_1	VI	54.8	1,500	28	75	2.62	.06	750	600+	171	3.4	1.95
G_2	I	50	2,000	40	75	2.62	.16	1,283	600+	149	2.9	1.7
G_3	VII	72	1,600	22	*	2.62	.13	1,300	600+	85	....	....
H_1	VII	72	3,000	41	53	1.93	.04	....	470	94	....	....
H_2	VIII	81	1,800	27	†	1.93	....	....	.....	497	1.1	.65
I_1	VI	127	4,800	38	88	1.88	.04	....	600+	193	6.5	3.8
I_2	VI	48	2,900	60	88	1.88	.07	....	527	...	6.2	3.6
I_3	VI	48	2,900	60	88	1.88	.04	....	540	211	....	....
J_1	VIII	72	3,860	54	120	2.25	.11	....	600+	36	....	....
K_1	III	72	2,000	28	61	1.54	.04	....	600+	174	....	....
L_1	III	90	3,000	33	65	1.99	.05	....	575	104	....	....
L_2	II	85	3,000	35	65	1.99	....	....	.....	138	....	....
M_1	II	160	8,500	53	130	2.46	.02	....	577	28	3.2	1.8
N_1	XIII	65	2,000	31	100	3.26	.05	....	600+	44	4.0	2.3
O_1	IX	41	3,300	80	102	2.52	.12	....	578	60	9.4	5.4
P_1	X	60	3,000	50	60.5	1.61	.06	1,617	.....	146	....	....
P_2	X	63	2,500	40	60.5	1.61	....	....	.....	108	....	....
P_3	XII	75	2,260	30	60.5	1.61	....	....	.....	92	....	....
Q_1	XIII	50	2,000	40	80.8	2.02	.07	....	.....	138	4.2	2.4
R_1	XIV	82.5	2,500	30	44	.74	....	....	.....	164	....	....
R_2	XIV	82.5	2,500	30	44	.74	.08	....	530	240	....	....
R_3	VI	45	5,030	112	†	.74	.13	....	420	900	....	....
R_4	XIV	82.5	5,030	61	44	.74	.03	....	450	245	....	....
S_1	XV	40	6,000	143	142	1.00	.20	....	.....	32	3.9	2.3
T_1	XVI	35	6,000	172	170	.98	.41	....	779	40	....	....
U_1	XVII	80	7,530	94	83	.88	.26	1,400	492	74	....	....
V_1	XV	34	11,000	324	197	.87	.12	1,600	396	38	....	....
V_2	XV	26	11,000	425	197	.87	.12	1,530	377	77	....	....
V_3	XIV	160	11,000	69	†	.87	.16	1,000	356	365	....	....
W_1	XVIII	48	4,400	67	93	1.37	.14	1,700	450	64	4.0	2.3

* Heavy feed. † Light feed.

No. of furnace		Draft in Inches of Water		Lbs. of bagasse, wet, per sq. ft. G. S. per hour	Cu. ft. of air delivered by blower per lb. of dry bagasse	FLUE GAS ANALYSIS				Excess of air, per cent	Furnace temperature
		Stack	Furnace			% CO_2	% O	% CO	% N		
1		5	6	7	8	9	10	11	12	13	14

TABLE IV.

1	2	3	4	5	6	7	8	9	10	11	12	13
No. of furnace	Type of furnace	Grate surface, sq. ft.	Heating surface, sq. ft.	Ratio of H. S. to G. S.	Lbs. of bagasse burned per sq. ft. of G. S. per hour	Lbs. of bagasse burned per sq. ft. of H. S. per hour	Furnace draft, inches of water	Furnace Temp., degrees Fahr.	Stack Temp., degrees Fahr.	Per cent exces air	PRESSURE OF AIR IN BLOWER DISCHARGE	
											Inches of water	Ounces per sq. in.
	Figure											
A_1	I	50	3,188	64	121.0	1.84	.06	1,012	596	94	7.5	4.30
B_1	II	72	1,540	21	63	2.98	....	1,235	600+	45	1.25	.72
C_1	III	78	3,050	39	72	1.90	.07	1,095	506	122	10.	6.30
D_1	IV	78	3,000	38	105	2.72	.13	1,225	501	72	....	....
E_1	V	82	2,268	28	147	5.30	.07	1,300	600+	77	3.2	1.85
F_1	VIII	99	7,762	78	123	1.57	.03	1,500	600+	102	2.7	1.55
G_1	VI	54.8	1,500	28	75	2.62	.06	750	600+	171	3.4	1.95
G_2	I	50	2,000	40	75	2.62	.16	1,283	600+	149	2.9	1.7
G_3	VII	72	1,600	22	*	2.62	.13	1,300	600+	85	....	....
H_1	VII	72	3,000	41	53	1.93	.04	....	470	94	....	....
H_2	VIII	81	1,800	27	†	1.93	....	....	.....	497	1.1	.65
I_1	VI	127	4,800	38	88	1.88	.04	....	600+	193	6.5	3.8
I_2	VI	48	2,900	60	88	1.88	.07	....	527	...	6.2	3.6
I_3	VI	48	2,900	60	88	1.88	.04	....	540	211	....	....
J_1	VIII	72	3,860	54	120	2.25	.11	....	600+	36	....	....
K_1	III	72	2,000	28	61	1.54	.04	....	600+	174	....	....
L_1	III	90	3,000	33	65	1.99	.05	....	575	104	....	....
L_2	II	85	3,000	35	65	1.99	....	....	.....	138	....	....
M_1	II	160	8,500	53	130	2.46	.02	....	577	28	3.2	1.8
N_1	XIII	65	2,000	31	100	3.26	.05	....	600+	44	4.0	2.3
O_1	IX	41	3,300	80	102	2.52	.12	....	578	60	9.4	5.4
P_1	X	60	3,000	50	60.5	1.61	.06	1,617	.....	146	....	....
P_2	X	63	2,500	40	60.5	1.61	....	....	.....	108	....	....
P_3	XII	75	2,260	30	60.5	1.61	....	....	.....	92	....	....
Q_1	XIII	50	2,000	40	80.8	2.02	.07	....	.....	138	4.2	2.4
R_1	XIV	82.5	2,500	30	44	.74	....	....	.....	164	....	....
R_2	XIV	82.5	2,500	30	44	.74	.08	....	530	240	....	....
R_3	VI	45	5,030	112	†	.74	.13	....	420	900	....	....
R_4	XIV	82.5	5,030	61	44	.74	.03	....	450	245	....	....
S_1	XV	40	6,000	143	142	1.00	.20	....	.....	32	3.9	2.3
T_1	XVI	35	6,000	172	170	.98	.41	....	779	40	....	....
U_1	XVII	80	7,530	94	83	.88	.26	1,400	492	74	....	....
V_1	XV	34	11,000	324	197	.87	.12	1,600	396	38	....	....
V_2	XV	26	11,000	425	197	.87	.12	1,530	377	77	....	....
V_3	XIV	160	11,000	69	†	.87	.16	1,000	356	365	....	....
W_1	XVIII	48	4,400	67	93	1.37	.14	1,700	450	64	4.0	2.3

* Heavy feed. † Light feed.

TABLE V.

No. of furnace	Description of Furnace	No. of Test	Conditions Under Which the Test Was Made	Draft in Inches of Water		Lbs. of bagasse, wet, per sq. ft. G. S. per hour	Cu. ft. of air delivered by blower per lb. of dry bagasse	Flue Gas Analysis				Excess of air, per cent	Furnace temperature
				Stack	Furnace			% CO_2	% O	% CO	% N		
1	2	3	4	5	6	7	8	9	10	11	12	13	14
A_1	Fig. I, Stirling bottle-neck. 319 H. P. water tube boiler	1	See foot note	0.70	0.07	121	....	10.3	9.8	0.08	79.8	94	....
	Boiler setting close	2	Draft doors closed	0.80	0.08	121	....	11.4	8.1	0.10	80.4	75	950
		3	Draft doors closed. Damper closed 1″. Fan discharge	0.75	0.07	121	....	12.1	7.3	0.40	80.2	65	1500
		4	Draft doors closed. Damper closed 2″. Fan discharge	0.80	0.08	121	....	11.9	7.1	0.15	80.8	68	1200
		5	See foot note	0.90	0.05	121	46	11.3	7.8	0.30	80.6	77	1012
		6	Draft doors closed	0.80	0.08	121	38	10.9	8.5	0.36	80.2	83	1330
B_1	Fig. II, Burt furnace. 128 H. P. H. R. T. boilers	7	See foot note	0.30	....	63	29.4	8.4	10.9	0.25	80.5	138	1217
	Boiler setting leaky	8	See foot note. Gas sample taken from back connection	0.30	....	63	29.4	13.8	5.5	0.60	80.1	45	1250
C_1	Fig. 3. 300 H. P. H. R. T. boilers	9	See foot note	0.40	0.09	76	68.4	4.9	15.5	0.00	79.6	308	1125
	Boiler setting leaky	10	Gas sample taken from back connection	0.40	0.05	76	....	7.3	12.8	0.00	79.9	174	1067
		11	Gas sample taken from back connection. Stack damper closed 25%	0.55	0.07	76	68.4	11.7	7.8	0.00	80.5	71	1050
D_1	Fig. IV, dutch oven. 300 H. P. H. R. T. boilers	12	See foot note	0.60	0.13	105	....	6.8	12.9	0.00	80.3	195	1075
		13	See foot note. Gas sample taken from back connection	0.60	0.14	105	....	11.6	8.5	0.00	79.9	72	1400
E_1	Fig. V, hearth furnace. 200 H. P. H. R. T. boiler	14	See foot note	0.50	0.07	147	31.2	11.3	7.9	0.00	80.8	77	1300
F_1	Fig. VIII, dutch oven. 100 H. P. H. R. T. boiler	15	See foot note	0.60	0.03	123	29.7	9.9	4.8	0.30	85.0	102	1500
G_1	Fig. VI, Stirling. 150 H. P. water tube boiler	16	See foot note	0.45	0.06	75	37.0	1.1	19.7	0.00	79.2	1720	750
		17	Damper closed 30%	0.20	0.06	75	28.0	7.0	13.0	0.00	80.0	186	1050
		18	Damper closed 50%	0.23	0.04	75	23.8	7.8	12.5	0.06	79.6	157	1200
G_2	Fig. I, Stirling bottle-neck. 200 H. P. water tube boiler	19	See foot note	0.62	0.16	75	57.0	5.4	13.4	0.10	81.0	270	1283
		20	Damper closed 33%	0.60	0.13	75	57.0	9.4	10.1	0.00	80.5	113	1525
		21	Damper closed 45%	0.70	0.11	75	57.0	12.2	7.4	0.07	80.3	64	1500
G_3	Fig. VII, C. and H. dutch oven. 200 H. P. H. R. T. boiler	22	Very heavy feed. See foot note	0.70	0.13	.....	40.0	9.1	10.1	0.00	80.8	120	1300
		23	Damper closed 33%	0.70	....	.....	....	12.6	7.2	0.00	80.2	50	....
H_1	Fig. VII, C. and H. dutch oven. 250 H. P. H. R. T. boiler.	24	Draft doors open 3″ at top	0.65	....	53	....	10.3	10.2	0.00	79.5	94	1350
		25	Damper closed 25%	0.40	0.10	53	....	13.7	6.4	0.20	79.7	46	....
		26	Damper closed 25%. Draft doors closed	0.37	0.21	53	....	14.3	5.2	0.80	79.7	40	1375
H_2	Fig. VIII, dutch oven. 150 H. P. H. R. T. boiler	27	Light feed. Draft doors opened 2″ at top	0.44	0.13	53	....	3.7	16.9	0.00	79.4	450	....
		28	Light feed. Natural draft	0.42	0.04	53	....	3.1	17.1	0.00	79.8	545	....
I_1	Fig. VI, Stirling dutch oven. 500 H. P. water tube boiler.	29	See foot note	0.75	....	88	38.5	8.3	11.4	0.20	80.1	141	....
		30	See foot note. Using 4 oil burners in addition to bagasse	0.70	0.04	88	34.8	8.6	10.5	0.10	80.7	133	....
		31	Damper closed 50%	0.60	0.04	88	34.0	5.8	14.4	0.00	79.8	245	....
		32	Damper closed 50%	0.60	0.03	88	45.0	7.8	12.4	0.00	79.8	156	....
		33	Damper closed 50%. Draft door closed	0.40	0.05	88	45.0	5.1	14.8	0.00	80.1	292	....
I_2	Fig. VI, Stirling. 290 H. P. water tube boiler	34	See foot note. Using 2 oil burners in addition to bagasse	0.60	0.07	88	47.0	4.4	15.3	0.07	80.2	354	....
I_3	Fig. VI, Stirling. 290 H. P. water tube boiler	35	See foot note. Induced draft by steam jet in stack	0.75	0.08	88	....	5.5	14.6	0.10	80.8	264	....
		36	See foot note. Steam jet off. Natural draft	0.60	0.04	88	....	6.8	13.0	0.00	80.2	194	....
		37	Steam jet off. Damper closed 66%	0.60	....	88	....	7.3	12.4	0.00	80.3	174	....
J_1	Fig. VIII, dutch oven. 325 H. P. H. R. T. boiler	38	See foot note. Natural draft	0.40	0.11	120	....	13.7	5.5	0.30	80.5	46	....
		39	Damper closed 33%. Blower engine making 160 R. P. M	0.17	0.08	120	12.8	15.0	5.2	0.10	79.7	33	....
		40	Damper closed 66%. Blower engine making 220 R. P. M	0.10	0.02	120	12.8	16.8	2.0	1.60	79.6	19	....
K_1	Fig. III, Fisher.. 250 H. P. H. R. T. boiler	41	See foot note	0.45	0.04	61	....	7.3	11.4	0.30	81.0	174	....
L_1	Fig. XI, retort furnace. 250 H. P. H. R. T. boiler	42	See foot note. Draft doors closed	0.40	0.05	65	....	9.0	10.3	0.40	80.3	122	....
		43	See foot note. Draft doors closed. Two oil burners on in addition to bagasse	0.40	0.04	65	....	10.7	7.2	0.30	81.8	87	....
L_2	Fig. II, Burt furnace. 250 H. P. H. R. T. boiler	44	See foot note. Five oil burners on in addition to bagasse	0.40	....	65	....	8.4	10.7	0.07	80.8	138	....
M_1	Fig. XI. retort furnace. 700 H. P. H. R. T. boiler	45	See foot note. Draft doors closed	0.30	0.02	130	19.5	16.3	3.16	0.46	80.2	28	....
N_1	Fig. XIII, Burt furnace. 170 H. P. H. R. T. boiler	46	See foot note	0.75	0.06	100	....	10.6	8.5	0.50	80.3	89	....
		47	See foot note. Gas sample taken from back connection	0.65	0.05	100	10.6	13.5	6.1	0.10	80.3	48	....
		48	Draft doors closed. Gas sample taken from back connection	0.70	....	100	10.6	12.8	6.5	0.07	80.5	56	....
		49	Draft doors, fire doors, dampers closed. Gas sample taken from back connection	0.70	0.06	100	7.5	15.0	4.0	0.60	80.3	33	....
O_1	Fig. IX, dutch oven. 250 H. P. Scotch marine boiler	50	See foot note	0.20	0.12	102	33.6	12.8	5.1	0.25	81.9	56	....
		51	Draft doors closed	0.20	0.16	102	32.4	12.3	7.2	0.07	80.4	63	....
P_1	Fig. X, dutch oven. 300 H. P. Cook boiler	52	Oil burned with bagasse. See foot note	....	0.06	60.5	....	7.4	12.5	0.02	80.1	170	1617
		53	Oil burned with bagasse. Draft doors closed	....	0.05	60.5	....	9.0	10.2	0.00	80.8	122	1587
P_2	Fig. X, dutch oven. 250 H. P. Cook boiler	54	See foot note	0.35	....	60.5	....	9.6	10.2	0.00	80.2	108	....
P_3	Fig. XII, dutch oven. 200 H. P. H. R. T. boiler	55	Draft doors closed	0.60	....	60.5	....	7.4	11.7	0.00	80.9	170	....
		56	Draft doors closed. Gas sample taken from back connection	0.70	....	60.5	....	10.4	9.0	0.00	80.6	92	....
Q_1	Fig. XIII, Burt furnace. 175 H. P. H. R. T. boiler	57	Draft doors closed	0.40	0.07	80.8	....	4.8	15.2	0.10	79.9	220	....
		58	See foot note	0.45	0.07	80.8	....	12.9	5.8	0.20	80.1	55	....
R_1	Fig. XIV, step grate dutch oven. 240 H. P. B. & W. boiler	59	Draft doors open 10″	0.50	0.06	44	....	6.2	14.3	0.00	79.5	222	....
		60	Draft doors open 4″	....	0.20	44	....	9.7	10.6	0.00	79.7	106	....
R_2	Fig. XIV, step grate dutch oven. 260 H. P. DeNayer boiler	61	See foot note	0.40	0.08	44	....	5.9	14.4	0.00	79.7	240	....
R_3	Fig. VI, dutch oven. 500 H. P. Stirling boiler	62	Very light feed. See foot note	0.30	0.13	44	....	1.9	17.4	0.00	80.7	900	....
R_4	Fig. XIV, step grate dutch oven. 500 H. P. Stirling boiler	63	See foot note	0.55	0.03	44	....	5.8	14.4	0.00	80.0	245	....
S_1	Fig. XV, Cook furnace. 300 H. P. B. & W. boiler	64	See foot note. Fires not good	0.50	0.21	142	....	9.9	10.1	0.00	80.0	102	....
		65	Fires very good	0.50	0.20	142	....	15.2	4.1	0.00	80.7	32	....
		66	Fires poor	0.65	0.08	142	....	7.0	13.0	0.00	80.0	185	....
T_1	Fig. XVI, dutch oven. 600 H. P. Climax boiler	67	Natural draft. Damper closed 50%. Draft doors opened 13″	0.25	0.32	170	....	17.9	1.0	1.80	80.2	17	....
		68	See foot note. Natural draft	0.49	0.41	170	....	12.2	7.7	0.00	80.1	64	....
U_1	Fig. XVII, 625 H. P. H. R. T. boiler	69	Fire very deep on grate. Fire doors opened 3″ at top	0.46	0.26	83	....	11.5	8.7	0.00	79.8	74	1400
V_1	Fig. XV. Cook furnace. 1100 H. P. B. & W. boiler	70	See foot note	0.90	....	197	....	14.5	4.9	0.30	80.3	38	1600
V_2		71	See foot note	0.70	0.12	197	....	11.3	7.1	0.90	80.7	77	1530
V_3	Fig. XIV, step grate dutch oven. 1100 H. P. B. & W. boiler	72	Impossible to burn more than a very light feed. See foot note	0.80	0.16	197	....	4.3	15.7	0.00	78.0	365	1000
W_1	Fig. XVIII, dutch oven. 440 H. P. B. & W. boiler	73	See foot note	1.00	0.14	93	....	11.9	7.0	0.10	81.0	68	1700
		74	Damper closed 50%	1.10	0.09	93	....	12.5	6.2	0.20	81.1	60	1630

NOTE.—Where not mentioned, it will be understood that stack dampers, draft doors, and fan discharge dampers were wide open, and that the sample of the flue gas was taken from the stack, bagasse was the only fuel, and forced draft was used.

DISCUSSION OF DATA ON FURNACE TESTS.

BAGASSE—The data relating to this subject is in Col. 3 of Table I and Cols. 3 to 8, inclusive of Table II. The heat value of the dry bagasse in the Louisiana factories varied from 8283 B. T. U. at factory H to a maximum of 8431 B. T. U. at factory B, the average being 8368.

In the Cuban factories it varies from a minimum of 8300 B. T. U. at factory V to a maximum of 8650 B. T. U. at factory U, the average being 8433 B. T. U.

These figures show a remarkably small variation in the heat values of the bagasse from different plantations, the maximum variation from the average being about 1% in the Louisiana houses and 2.5% in the Cuban houses. Theoretically, the heat value of dry bagasse composed of cellulose only should always be the same. The actual bagasse, however, has two principle variables in it—ash and sucrose—which affect its heat value. The sucrose, having a heat value per pound practically the same as that of cellulose, can not affect it greatly. At the beginning of these investigations it was, therefore, decided to make careful determinations of the ash in each sample of bagasse, along with the calorimeter tests, for the purpose of determining if there is any uniform relation between the per cent ash and the heat value of bagasse. It is evident that if there is any such relation an increase in the amount of ash should cause a corresponding decrease in the heat value per pound.

Col. 4, Table II, gives the per cent ash, based on dry bagasse. Inspection of these figures shows the ash to have varied from a minimum of 0.85% to a maximum of 1.44%, with an average of 1.14% in the Louisiana bagasse. In the Cuba bagasse it varied from a minimum of 0.75% to a maximum of 0.87%, with an average of 0.79%. Comparing these averages with the corresponding averages of heat values stated above, we find that with an average heat value of 8368 B. T. U. there was an ash of 1.14% in Louisiana and in Cuba an average heat value of 8433 B. T. U., with an average of 0.79% ash. As the ash is not combustible, the 8433 B. T. U. for Louisiana represents the heat from 1.0 — .0114 =0.9886 pounds of combustible and the corresponding heat per pound of combustible would be $\frac{8433}{.9886}$=8530 B. T. U. A similar calculation for the Cuba bagasse would give a combustible of 1.0 — .0079 = 0.9921 pounds, corresponding to a heat value of 8433 B. T. U. This would give $\frac{8433}{.9921}$ =8500 B. T. U. per pound of combustible. The close proximity of these heat values per pound of combustible (8530 B. T. U. and 8500 B. T. U.) would seem to indicate that the varying ash in different bagasses accounts largely for their differences in heat value. The sucrose was not determined for all the houses where tests were made and for this reason no mention was made of it in the tables. However, the average of sucrose in bagasse for five mills in Louisiana was 5.79% and for the same number of mills in Cuba 6.17%. This is somewhat unexpected, as the Cuban mills were mainly of the nine-roller type, whereas those in Louisiana are six-roller mills. However, the moisture, Col. 3, Table II, in the bagasse from the Cuban mills was less, being an average of 50.2%, varying from 51% to 53%, as against an average in Louisiana of 52.1%, varying from 50% to 54.3%. This shows a very small variation in mill work.

The net heat value of one pound of wet bagasse, Col. 7, Table II, the manner of calculating which has been explained, varies also within small limits, the average for Louisiana being 3312 B. T. U. and for Cuba 3367 B. T. U., the maximum variation from the average in the former being 8.3% and in the latter 4%.

COMBUSTION OF BASSAGE.

FLUE GAS ANALYSIS—The conditions encountered as regards flue gas analysis are shown in Cols. 9 to 13, inclusive, in Table V. To say the least of it, these figures show large variations in furnace conditions, though in very few cases was there enough CO to indicate appreciable loss from incomplete combustion, or, in other words, lack of air. It may be seen by a study of these figures that with few exceptions appreciable quantities of CO were accompanied with less than 50% air excess—that is, with adjustments of the stack, damper, draft, doors, etc., such as to materially reduce the air supply, though small quantities of CO are found, with very large quantities of excess air, due, no doubt, to the difficulty of thorough admixture of the products with the air supplied, the air supply in large part coming through the uncovered grate at the edges of the pile, and therefore not well distributed through the fuel. It would seem, therefore, that in bagasse burning the problem is to reduce the air excess to the minimum, 50% being evidently sufficient, though with other solid fuels this would be considered too small an allowance.

The average gas analysis for all tests is 9.01% CO_2, 9.83% O and 0.17% CO. This would be considered a fair analysis for coal, though for bagasse there are many analyses in the table giving evidence that the % CO_2 can and should be higher. The best analysis, judging from CO_2 content, is that in test 67, with 17.9% CO_2, 1.0% O and 1.8% CO. The % CO may perhaps be too large in this case, though the writer questions this, so that perhaps such an analysis as that in test 45, with 16.3% CO_2, 3.16% O and 0.46% CO should be taken as being more desirable. It should be noted that in the average analysis given above the sum of the three components is 19.01%—that is, 2% less than the theoretical 21%, the quantity that should exist were the carbon compounds and oxygen the sole constituents of the gases analyzed. In many of the tests this deficiency is seen to be still greater, as, for example, in test 50 this sum is only 18.15%. It is likely that all steam contained in the gases would be condensed in the sampling apparatus so that none would reach the analyzing apparatus. It appears, therefore, that there must be small quantities of compounds other than the carbon oxides in the gases. These could be either free hydrogen or unburned hydrocarbons, neither of which can be determined with the Orsat apparatus used. It was thought that the discrepancy might have been due to some fault in the analyzing instrument, but it was carefully overhauled and tested and found reliable. The data of the table seems to show no particular relation between this quantity and other variables, such as form of furnace, temperature of furnace, etc. In the future we hope to procure an instrument by which to investigate this matter more fully, determining more of the constituents than we were able to determine with the apparatus used in these tests.

RATE OF COMBUSTION.

The data on this subject is found in Col. 7, Table V. A study of the same shows some interesting relations with the flue gas analysis and furnace temperatures which are found in the same table. The rate of combustion varies from a minimum of 44 at factory R to a maximum of 197 at factory V. There seems to be greater variation in this than in any other one factor in the burning of bagasse and in the opinion of the writer, after much observation and experimental work, it is one of great importance.

The figures upon the rate of combustion (pounds of bagasse per sq. ft. of grate per hour) can not be regarded as more than approximately accurate except in the small factories tested, where the bagasse was burned in one or two furnaces of the same type and dimensions. As already explained, the weight of the bagasse was found by subtracting the total juice of the factory from the total cane ground, no weighing being made of the bagasse fed to each separate furnace, which, for obvious reasons, would have been practically impossible, or, at least, very difficult. The rate of combustion was found by dividing the total bagasse per hour by the total grate surface of the factory. In some of the factories as many as four furnaces were tested and it is, of course, unreasonable to assume that the feed and furnace conditions were such as to give the same rate in each, especially as the tests were not made at the same time. However, as the different furnaces of a factory have, in most cases, the same source of air supply and the same grate arrangement, it was possible, by carefully watching and adjusting the feed to the individual furnaces, to insure a practically constant rate of combustion in the different furnaces, not differing radically from the factory rate found in the table. On account of the approximate nature of this data some inconsistencies will appear in the comparisons which will now be made. Comparing the corresponding rates of combustion and excess air in Cols. 6 and 11, respectively of Table IV, we find that in a general way, the per cent excess air is inversely proportional to the rate of combustion. This may be seen better by grouping the tests and using the averages for comparison. Averaging the rates of combustion and the corresponding per cents of excess air for rates of combustion of 40 to 80, inclusive, we get an average rate of 60.2, with an average air excess of 142%. Likewise, for rates of combustion of 80 to 120, inclusive, the average rate is 94.3, with an average air excess of 96.6. For rates of combustion above 120 the average rate is 159, with an average air excess of 61. Plotting a curve with these rates of combustion and per cents excess air as coordinates gives practically a straight line. The reasons underlying the above relations have been explained at length. Through the data obtained in these tests the writer is led to believe that the rate of combustion should be not less than 100—in fact, the best furnace performance found in the tests was with rates entirely above this, notable examples of which are to be seen in furnaces A_1, E_1, J_1, M_1, S_1, T_1, V_1 and V_2. Evidence of the good results from such operation will be found in the high furnace temperatures and good gas analyses; also the low stack temperatures, except in cases where the heating surface was insufficient.

DEPTH OF FUEL BED.

Another means of reducing the excess air closely related to the above is that of increasing the depth of the fuel on the grate and especially at the edges. No data upon this is shown in the tables, but it was observed that in nearly all cases the best results were obtained in furnaces in which the grate was completely covered at the edges to a depth of several inches, which, of course, reduces the possibility of unmixed air passing through. Tests 45, 65, 67, 69, 70 and 73 were made under such conditions, the depth of the fuel at the edges of the grate being in no case less than about 15 inches. In each of these the fuel was fed from a single point above so that piles of pyramydal or, in test 67, conical shapes were formed, the least depth of which was as just stated.

CONTROL OF THE RATE OF COMBUSTION.

The question naturally arises, can the rate of combustion be controlled in design and in operation, and, if so, how? Of course, it will depend, first, upon the moisture in the bagasse, other things being equal, the greater the moisture, the lower the rate of combustion that is possible. On the other hand, no matter what the moisture content (within reasonable limits) large rates may be obtained by supplying a sufficient quantity of air to it, with a sufficient pressure. This means that a strong chimney draft must be arranged for in case of natural draft or a sufficient blower capacity in case of forced draft. In order to carry thick fuel beds, as advocated above, the air pressure must, of course, be stronger than for thinner fires. From Columns 12 and 13 of Table IV it seems, however, that the pressures required are not very high. It will be seen that the blower pressure varied in those tested, from 1.1 to 10.1 inches of water, the pressure being observed in the discharge pipe near the blower. With no fuel on the grate the pressure on the blower would be practically nothing—in other words, the pressure is proportional to the resistance to the flow of air through the fuel or through the air pipes. The figures just referred to may, therefore, be taken to roughly indicate the relative depths of the fuel on the grate, provided the resistance in the air pipes was the same in all cases. Col. 8, Table V, gives the volume of air in cu. ft. supplied by the blower per pound of dry bagasse. The average of those tested is 33.4 cu. ft. per pound, varying from a minimum of 7.5 to 68.4 cu. ft. per pound. With a moisture in bagasse of 52% this would be equivalent to an average of $33.4 \times 1 - 0.52 = 33.4 \times .48 = 16.03$ cu. ft. of air per pound of bagasse as fired.

In order to obtain some knowledge of what proportion the volume of air supplied by the blower is of the total supplied we may calculate the latter. Take, for example, the test on furnace E_1, the air supplied by the blower being 31.2 cu. ft. per pound of dry bagasse and the gas analysis 11.3% CO_2, 7.9% O and 0.0% CO. A calculation based upon this flue gas analysis shows a total supply of 126.1 cu. ft. per pound of dry bagasse, or, in other words, only $\frac{31.2}{126.1} \times 100 = 24.7\ \%$ by the blower, the balance leaking in at the hoppers, through grate, cracks, etc.

The rate of combustion (pounds of bagasse per sq. ft. of grate per hour) in a furnace burning a given amount of fuel per unit of time will depend upon the size of the grate—that is, to increase the rate of combustion without changing the total fuel per unit of time, the grate area must be decreased. The question of the proper grate area will be discussed later in connection with that of heating surface.

RELATION OF FURNACE TEMPERATURE TO AIR EXCESS.

From what has been explained on former pages we should expect higher furnace temperatures as the excess air is decreased, though there are, of course, other variables affecting the furnace temperature, principal of which is the thoroughness of mixing the products arising from the fuel fed. The pyrometer used for determining the furnace temperature was a reliable instrument, but very delicate, and, unfortunately, had to be sent to the factory for repairs during the time occupied by the experiments. For this reason it was necessary to make a large number of the tests without it, as will be seen from the tables (Table IV, Col. 9, and Table V, Col. 14). After making a large number of observations of furnace temperature, however, with the instrument the observer became practiced in estimating it from the color of the furnace and the brick walls of the furnace, and such estimates, though approximate, were made for all the tests, while the pyrometer was out of commission. The values thus obtained are given in the accompanying table.

No. of Test.	Furnace Temp.	No. of Test.	Furnace Temp.
29	1200	56	1500
30	1350	58	1200
41	1200	59	1250
42	1400	60	1400
44	1300	61	1050
45	1550	62	800
46	1250	63	1000
47	1300	64	1300
48	1300	65	1600
49	1300	66	1200
50	1400	67	1500
51	1400	68	1400
54	1600		

By arranging the different tests where the pyrometer was used in three groups, in which the excess air ranges from 20 to 70 per cent, 70 to 120 per cent and 120 per cent upward, respectively, and averageing the per cents of excess air and the corresponding furnace temperatures in each group; we get with an average air excess of 55.4% an average furnace temperature of 1475°; with an average air excess of 85% an average furnace temperature of 1290°, and with an average air excess of 272% an average furnace temperature of 1146°. These averages include the tests made with bagasse only as the fuel, tests 52 and 53 being omitted, as oil was burned with the bagasse in them. These averages show, roughly, at least, that the furnace temperature varies inversely with the per cent of air excess, though not according to a definite proportion. The latter, however, is not to be expected, as the furnace temperature depends upon other variables besides the quantity of excess air and for the further reason that the observed temperatures could not all be taken at the hottest portion of the furnace.

AIR SUPPLY.

From the foregoing it would seem that the regulation of the air supply, generally to cut down the surplus, is of considerable importance, as by that means the furnace temperature is increased, which means transfer of a larger proportion of the heat generated to the water in the boiler. In order to study the effects produced by the various methods of controlling the air supply, various experiments were made in which the speed of the blower, the opening of the stack damper, the opening of the ash pit doors, etc., were varied, observations of flue gas analysis, air excess, stack draft and temperature, furnace draft, and, in some cases, furnace temperature, showing the effects produced. Comparisons of this nature are best made by changing conditions in the same furnace and observing the effects. Following are partial running logs for tests of this kind upon a number of furnaces, the conditions under which they were made being stated at the end of each log.

Readings	% CO₂	% O	% CO	% N	% Ex-cess Air	Stack Temp.	Stack draft	Furnace Temp.	Furnace draft
				Test No. 16.					
1	2.0	17.2	0.0	....	....	600 plus	....	600	.09
2	1.2	19.8	0.0	....	....	“ “	.45	....	.07
3	0.2	21.0	0.0	....	....	“ “	....	900	.06
Ave.	1.13	19.7	0.0	79.2	1720	600 plus	.45	750	.07
				Test No. 17.					
4	6.6	13.4	0.4	....	....	600 plus	.30	1050	.06
5	6.2	13.8	0.0	....	....	“ “	....	800	.08
6	7.8	12.2	0.0	....	....	“ “	.20	1050	.06
Ave.	6.9	13.1	0.1	79.9	190	600 plus	.25	967	.07
				Test No. 18.					
7	6.6	13.4	0.2	....	....	600 plus	.15	1100	.04
8	8.0	12.6	0.0	....	....	“ “	.25	....	....
9	9.0	11.0	0.0	....	....	“ “	.25	....	....
10	8.4	12.6	0.1	....	....	“ “	.25	1300	.04
11	7.0	13.2	0.0	....	....	“ “	....	....	....
Ave.	7.8	12.6	.06	79.6	156	600 plus	.23	1200	.04

Test No. 16—Draft doors and damper open.

Test No. 17—Draft doors open; damper closed 30%.

Test No. 18—Draft doors open; damper closed 50%.

By reference to Table V we note that the grate of this furnace was relatively large, only about 75 pounds of bagasse being burned per sq. ft. per hour. It will be noticed that as the stack damper is closed more and more the flue gas analysis improves, the air excess decreasing from 1720% to 156%. At the same time, there is a corresponding increase in the furnace temperature from 750° F. to 1200 F., which was naturally to be expected. The high stack temperature, however, is not so easy to explain, especially with the very low furnace temperatures. It is, however, due to the fact that with so much air the volume of gases and air is such as to cause a velocity so high that the time of contact with the heating surface is insufficient for absorption. Unfortunately, the stack temperature was too high to note any change due to decrease in air excess, with the thermometer used. It is interesting to notice also the decrease in the stack and furnace draft due to the partial closing of the damper and the draft doors. The supply of air through the blower was practically constant throughout the three tests. The furnace draft decreased from 0.07 inch of water in test 16 to 0.04 inch in test 18, thus approaching the balanced condition which has been referred to on former pages. The three tests above consumed several hours' time during which the feed was not far from constant.

Tests 24, 25 and 26, data for which is given in the table following, show much the same effects as for the above. The high stack temperature is no doubt due to the small ratio of heating surface to grate surface, which was only 41.

Readings	% CO_2	% O	% CO	% N	% Excess Air	Stack Temp.	Stack draft	Furnace Temp.	Furnace draft
					Test No. 24.				
1	9.6	11.0	0.0	....	....	600 plus	.7	....	....
2	11.1	9.4	0.0	....	....	" "	....	1325	....
3	10.3	10.2	0.0	....	....	" "	.6	1375	....
Ave.	10.3	10.2	0.0	79.5	94	600 plus	.65	1350	....
					Test No. 25.				
4	13.8	6.2	0.2	....	....	600 plus	.4	1500	.09
5	13.6	6.5	0.2	....	....	" "	.5	1625	.11
6	13.8	6.4	0.2	....	....	" "	.4	....	....
Ave.	13.75	6.4	0.2	79.7	46	600 plus	.4	1563	.10
					Test No. 26.				
7	14.4	5.2	0.6	....	....	600 plus	.40	....	0.21
8	14.2	5.2	1.0	....	....	" "	.35	....	....
Ave.	14.3	5.2	0.8	79.7	40	600 plus	.37	....	0.21

Test 24.—Stack damper open. Draft doors open 3 in. at the top.
Test 25.—Stack damper closed 25%. Draft doors open 3 in. at the top.
Test 26.—Stack damper closed 25%. Draft doors closed.

Increase in stack temperature due to increased air excess and wide open dampers and draft doors is clearly shown by comparing the data from tests 67 and 68 given in the following table. Both tests were made with natural draft only. Note the effect on the furnace and stack drafts due to damper and draft door manipulation. The high temperatures in the stack are probably due to the fact of very high furnace temperatures and that the boiler was of the vertical water tube type, with only one pass of the gases over the heating surface. Reference to Table IV shows that the ratio of heating surface to grate surface is 172. The high stack temperature can not, therefore, be due to lack of heating surface.

Reading	Per Cent CO_2	Per Cent O	Per Cent CO	Per Cent N	Per cent excess air	Stack Temp.	Stack draft	Furnace draft
Test No. 67.								
1	17.6	0.6	2.8	....	....	617	.25	.33
2	18.6	0.4	2.0	....	....	599	.22	.30
3	19.0	0.4	0.4	....	....	....	....	.23
4	18.4	0.2	3.8	....	....	666	.27	.30
5	18.8	0.4	1.4	....	....	669	.27	.35
6	17.6	1.8	0.4	....	....	644	.23	.35
7	15.4	3.1	1.9	....	....	637	.27	.35
Ave.	17.9	1.0	1.8	79.3	17	639	.25	.32
Test No. 68.								
8	14.0	5.4	0.0	....	....	788	.50	.42
9	10.4	10.0	0.0	....	....	770	.47	.40
Ave.	12.2	7.7	0.0	80.1	64	779	.49	.41

Test No. 67.—Draft doors open 13 in. at the top and the stack damper closed 50%.

Test No. 68.—Draft doors and damper wide open.

Stack temperatures taken with a pyrometer belonging to the factory.

Tests 38 to 40, inclusive, show results similar to those just discussed for other tests. The balanced condition of draft already referred to, may evidently be brought about in two ways—by reducing the stack draft or by increasing the quantity of air supplied by the blower. It will be seen in test 40 that with the damper closed 66% and with the blower running at its maximum speed the furnace draft is reduced to 0.02 inch of water, which indicates very nearly the balanced draft. In this case the flames were seen to roll and reverberate instead of the usual thin sheet with a high velocity. The feed in these tests was as nearly constant as it was possible to produce.

	Readings	% CO₂	% O	% CO	% N	% excess air	Stack Temp.	Stack draft	Furnace draft
Test No. 38	1	14.2	3.2	0.0	....	...	600+	0.4	....
	2	14.8	3.8	0.0	....	...	600+	0.4	....
	3	13.4	6.0	0.0	....	...	600+	0.4	.09
	4	13.2	6.0	0.0	....	...	600+	0.4	.09
	5	11.8	8.4	0.0	....	...	600+	0.4	.11
	6	15.0	3.0	2.0	....	...	600+	0.4	....
	7	14.6	5.0	0.6	....	...	600+	0.4	.11
	8	12.4	8.2	0.0	....	...	600+	0.4	.19
	Ave	13.7	5.5	0.32	80.5	46	600+	0.4	.11
Test No. 39	9	15.8	4.0	0.2	....	...	600	.25	.08
	10	14.2	6.5	0.0	....	...	590	.10	.09
	Ave	15.0	5.25	0.1	79.7	33	595	.17	.085
Test No. 40.	11	16.8	23.0	1.6	79.6	19	530	.10	.02

Test. No. 38—Draft doors and stack damper open. Natural draft used.

Test No. 39—Draft doors open. Stack damper closed 33%. Forced draft used. Blower engine making 160 R. P. M.

Test No. 40—Same as No. 39, except that the damper was closed 66% and blower engine making 220 R. P. M.

In the above tests we again have stack temperatures somewhat high, due, mainly, to the fact of a small ratio of heating surface to grate surface—that is, scanty heating surface, the ratio being 54. Unfortunately, the furnace temperature could not be measured, though it was estimated to be in the neighborhood of 1400° F.

The following tests were made in a furnace with ratio of heating surface to grate surface of 60 and in which about 88 pounds of bagasse were burned per square foot of grate per hour.

	Readings	% CO_2	% O	% CO	% N	% excess air	Stack Temp.	Stack draft	Furnace draft
Test No. 35	1	4.4	15.4	0.2	....	...	600	.8	.08
	2	6.6	13.8	0.0	....	...	580	.7	.08
	Ave	5.5	14.6	0.1	80.8	264	590	.75	.08
Test No. 36	3	7.0	13.0	0.0	....	...	550	.6	.04
	4	6.6	13.0	0.0	....	...	530	.6	.05
	Ave	6.8	13.0	0.0	80.2	194	540	.6	.045
Test No. 37	5	7.0	12.4	0.0	....	...	480	.5	....
	6	7.6	12.4	0.0	....	...	490	.7	....
	Ave	7.3	12.4	0.0	80.3	174	485	.6	....

TEST No. 35.—Draft doors and stack damper open. Induced draft by steam jet in stack.

TEST No. 36.—Draft doors and stack damper open. Steam jet off. Natural draft.

TEST No. 37.—Same as in 36 except the damper is closed 66%.

TESTS ON FURNACE V_1

Number	Time	CO_2	O	CO	Condition of fire	Furnace draft	Back connection draft	Stack draft	Furnace Temp.	Temp. in last pass
1	10:00	13.0	6.0	0.0	Fair	....	.55	...	.....	....
2	10:15	11.2	7.8	0.0	Fair	.4	.5	...	1700	....
3	10:30	15.0	3.3	0.1	Good	.24	.5	...	1600	....
4	10:45	13.0	6.4	0.0	Fair	.45	....	...	1700	440
5	11:00	13.3	7.0	0.0	Fair	.40	.45	...	1650	480
6	12:00	9.2	10.0	0.0	Low	.45	.4	.8	1400	500
7	12:15	15.0	4.2	0.0	Good	.45	.6	.9	1500	500
8	12:30	16.3	2.6	1.2	Good	.45	.65	...	1600	500
9	12:45	16.0	3.6	0.8	Good	.50	.65	...	1600	500
10	1:00	16.2	3.4	0.4	Good	.45	.65	...	1600	510
11	1:15	3.0	17.0	0.0	Good	.45	.70	...	1600	510
12	1:30	14.4	4.6	0.4	Good	.40	.80	1.0	1550	510
13	1:45	15.0	4.4	0.2	Good	.45	.80	1.0	1600	510

TESTS ON FURNACE G_2

Readings	Per Cent CO_2	Per Cent O	Per Cent CO	Per cent excess air	Stack Temp.	Stack draft	Furnace Temp.	Furnace draft	Blower—Static pres.	Blower—velocity head	REMARKS
1	6.0	13.4	0.0	...	600+	.6	1250	.18	2.8	.3	
2	4.0	13.4	0.2	158	600+	.6	1200	.17	3.0	.3	
3	6.2	13.6	0.1	168	600+	.65	1400	.13	3.0	.3	
Ave	5.4	13.4	0.1	166	600+	.62	1283	.16	3.0	.3	Damper wide open
4	11.4	7.6	0.0	55	600+	.55	1550	.14	2.8	.3	
5	7.4	12.6	0.0	146	600+	.65	1500	.12	2.9	.3	
Ave	9.4	10.1	0.0	89	600+	.60	1525	.13	2.95	.3	Damper closed 30%
6	12.4	7.4	0.1	53	600+	.7	1550	.11	2.9	.3	
7	12.0	7.0	0.2	49	600+	.7	1450	.10	2.9	.3	
8	12.4	7.4	0.0	53	600+	.7	1500	.11	2.9	.3	
9	12.2	7.8	0.0	58	600+	.7	....	..	...	...	
Ave	12.25	7.4	0.07	54	600+	.7	1500	.11	2.9	.3	Damper closed 45%

From the foregoing data it is evident that a stack damper may be made to serve a good purpose in the reduction of the amount of excess air, especially if forced draft is used, in which case the object of the stack is to carry the smoke away, the air being supplied by the blower. The position of the stack damper with such an arrangement would depend upon the rate at which the fuel is burned, the opening being less for the small feed and vice versa. The fact is, as shown by the data above, that the greatest losses through excess air occur with furnaces running below normal feed.

STACK TEMPERATURE.

The fact that the thermometer used for measuring the stack temperature was of a capacity below that required in many cases has been mentioned. A 1000° F. and a 700° F. thermometer were ordered for this purpose, but through a mishap only the latter arrived in time for most of the tests. The 700° F. instrument was found to register accurately as high as 600° only. However, even in the face of this fact, the figures show very plainly that the stack temperatures in the majority of the Louisiana houses were very high—in fact, much too high for a reasonable fuel economy. This was shown not only by the fact that so many of the readings were above 600°, but by the other evidences of great heat, such as the cracking off of the paint of the stack and the discoloration of the metal In many cases this was very noticeable. In fact, there is no doubt but that in several tests the temperature was between 700° and 800°, though in all such cases it is recorded as 600° +. In the Cuban factories, it will be noticed, the temperatures were generally satisfactorily low. Sometimes a high stack temperature is due to the burning of CO to CO_2 at the base of the stack when there is a supply of air through openings in the stack breeching. Since, however, the flue gas analysis shows an almost entire absence of CO in bagasse furnaces, such is not likely to be the cause of the high temperatures recorded. No doubt dirty flues may be the partial cause in a few cases, though in general the conditions in this respect were fully as favorable in the Louisiana as in the Cuban houses. In fact, in most of the plants tested this was given attention before the tests were begun.

The evidence of high stack temperatures due to the high velocity of the products of combustion with large air excess has already been discussed. Referring to Col. 10, Table IV, we find that in about 50% of the furnaces the stack temperature was above 600° F—in fact, evidences other than the thermometer, mentioned above, indicate that in the majority of these the temperature was at least 700° F. This is particularly true of furnaces B_1, E_1, G_3, I_1, N_1, P_1 and P_2. Of those furnaces in Louisiana with temperatures which could be measured with the thermometer the average is 540, the least being 420. In many of these, however, the temperature of the furnace was quite low, so that correspondingly low stack temperatures might be expected, other things being equal.

In only one of the Cuban houses was the stack temperature above 600° and that was in furnace T_1. Exclusive of this one, the average for the Cuban factories tested was 434°, varying from 356° to 530°.

RATIO OF HEATING SURFACE TO GRATE SURFACE.

The reason for the great difference of the stack temperatures in the Louisiana and Cuban houses is easily seen to be due to the great difference in the amount of their heating surface. In Column 5, Table IV, is recorded the data on this subject. The average ratio of heating surface to grate surface in the Louisiana houses is 42, while that for the Cuban houses, even after excluding furnaces S_1, V_1, V_2 and V_3, which are not of the grate type, is 90. Perhaps this same difference will be shown more clearly from the data in Column 7, Table IV, the average weight of bagasse burned per sq. ft. of heating surface per hour in Louisiana was 2.26 and that for Cuba was about 0.9. These figures seem to show that the main cause for high stack temperatures in the Louisiana houses is due to overloaded heating surface. This, it seems to the writer, is a matter of the greatest importance. According to the evaporative test made on furnace A_1, the data for which was given on page .., it may be expected that 2.25 pounds of water will be evaporated per pound of bagasse burned under ordinarily favorable conditions. Taking furnace D_1 as an example, there would be an equivalent evaporation of about $2.72 \times 2.25 = 6.1$ pounds of water per sq. ft. of heating surface per hour, whereas the normal evaporation should be in the neighborhood of 3 pounds. There is little wonder that the stack temperature is high under such conditions. Let us assume that an equivalent evaporation of 3.5 instead of 3 pounds of water per sq. ft. of heating surface per hour is permissible, then by reversing the order of the above calculation we get $\frac{3.5}{2.25} = 1.5$ as the proper weight of bagasse per sq. ft. of heating surface per hour. This would correspond to a ratio of heating surface to grate surface of $\frac{120}{1.5} = 80$, with a rate of combustion of 120, which the results of our tests seem to indicate as possible and advisable.

BOILER CAPACITY.

The fact that the heating surface in many of the houses is low means that the bagasse boilers are insufficient in capacity. The following table gives some interesting comparative data on the boiler horse power, etc., of a number of Cuban and Hawaiian houses, with which it will be profitable to compare the data in Table I on the same subject. In this table horizontal return tubular boilers are rated at 12 sq. ft. of heating surface per horse power, and water tube boilers at 10 sq. ft. per horse power. In making comparisons it should be remembered that the figures on horse power in the table represent the total of the factory, little fuel being used other than the bagasse except when the mill is not running—that is, they should be compared with the bagasse horse power in Table IV.

Grinding capacity in tons of cane per 24 hours	Style and size of Boiler	Number of Boilers	Square feet—total heating surface in Boilers	Square feet of total grate surface in Boilers	Total horse-power of Boilers	Ratios				Where located	Factory
						H. P. to tons of cane per 24 hours	H. S. to tons of cane per 24 hours	G. S. to tons of cane ser 24 hours	H. S. to G. S.		
2500	7 ft x 20 ft H.R.T.	12	30,000	296	2500	1.00	12.0	.123	102.	Hawaii	a
1000	7 ft x 20 ft H.R.T.	7	17,500	210	1458	1.46	17.5	.210	83.3	"	b
900	6 ft 4 in x 8 ft H. R.	8	13,580	192	1131	1.25	15.1	.211	70.7	"	c
2000	....	8 3	18,000 12,000	288 198	2700	1.35	15.0	.242	61.7	"	d
1250	6 ft x 20 ft H.R.T.	8	14,728	164	1225	.98	11.78	.132	89·0	"	e
500	7 ftx20 ft 6 ftx24 ft H.R.T. 7 ftx18 ft	3 1 1	9,707	116	809	1.62	19.4	.231	83.6	"	f
500	7 ftx20 ft 6 ftx20 ft H.R.T.	2 1	6,785	105	565	1.13	13.5	.211	64.6	"	g
500	6 ftx16 ft 6 ftx18 ft H.R.T. 6 ftx20 ft	2 1 1	7,740	111	645	1.29	15.5	.221	70.1	"	h
500	6 ft x 18 ft H.R.T.	4	6,188	88	516	1.03	12.37	.176	70.3	"	i
1000	7 ftx20 ft 6 ftx18 ft H.R.T.	5 1	14,050	179	1171	1.17	14.0	.177	79.0	"	j
1250	B & W	4–4000 2–1330	18,660	345	1866	1.49	14.9	.279	54.0	"	k
1077	....		14,994	208	1326	1.25	14.64	.201	75.3	"	Aver.
3750	B & W..................	16	88,000	256	8800	2.34	23.46	.068	343.0	Cuba	l
1250	Climax .... H.R.T................	6 3	29,160	180	2800	2.24	23.3	.144	162.0	"	m
1250	B & W	5 2	30,000	308	3000	2.4	24	.246	97.4	"	n
500	B & W..................	6	11,600	98	1160	2.3	23.2	.196	118.0	"	o
2500	Cimax..................	10	60,000	630	6000	2.4	24	.251	95.2	"	p
1250	B & W	6	30,000	144	3000	2.4	24	.115	208.0	"	q
900	B & W..	4	20,000	100	2000	2.2	22.2	.111	200.0	"	r
1628	....	....	38,394	245	3823	2.32	23.45	.157	174.8*	"	Aver.

*This average does not include furnace l which is not of the grate type.

In a 1000 tons per 24 hours plant, at 75% extraction, there would be about 250 tons of bagasse per 24 hours, which is approximately 10 tons, or 20000 pounds, per hour. According to data from the evaporative test this should evaporate, under good conditions, $20000 \times 2.25 = 50000$ pounds of water from and at 212° per hour, which is equivalent to $\frac{50000}{34.5} = 1449$ boiler horse power, or, roughly, 1500 horse power. This would give a ratio of boiler horse power to tons of cane per 24 hours of $\frac{1500}{1000} = 1.5$ for bagasse boilers. With 12 sq. ft. of heating surface per horse power, $1500 \times 12 = 18000$ sq. ft. of heating surface and $\frac{18000}{80} = 225$ sq. ft. of grate would be required.

BURNING OIL AND BAGASSE TOGETHER IN THE SAME FURNACE.

This seems to be a question upon which many sugar houses differ. The advantage of such an arrangement, as far as economic results are concerned, could only come by causing better combustion than with bagasse alone. On a former page the effect of the moisture in bagasse upon the chemical reactions in the furnace, and the temperature of dissociation, were discussed at length, and the conclusion reached that in cases where the temperatures are sufficiently high for dissociation a part of the heat lost in converting the moisture into steam might be recovered. Data gathered in our tests show that very high temperatures may be attained in this manner; temperatures higher than with either bagasse or oil alone. For example, in one dutch oven furnace, where the burning of bagasse and oil is the constant practice, temperatures of 2000° to 2400° were found repeatedly. This should certainly be high enough for dissociation. However, if this is practiced, care will have to be exercised to prevent overloading the heating surface from the high temperatures produced in the furnace.

An example may be shown in the furnace, P_2, just referred to above, in which the rate of combustion of bagasse was about 60, the stack temperature in the neighborhood of 700° F. and the ratio of heating surface to grate surface 40. This factory consumed during the season about 5 gallons of oil per ton of cane and the usual grinding is about 1400 tons per 24 hours. It is difficult to even approximate the proportion of the oil that was burned with the bagasse, but let us assume that it was 3 gallons per ton of cane. In 24 hours there would be, say, 1400 × .25 = 350 tons of bagasse and 3 × 1400 = 4200 gallons of oil burned together. 4200 gallons of oil, according to Table A, would be equivalent to 4200 × 60.5 = 214000 pounds, or 107 tons, of bagasse. The total bagasse equivalent would therefore be 350 + 107 = 457 tons per 24 hours, or about 38000 pounds per hour. This would evaporate, say, 38000 × 2.25 = 85500 pounds of water from and at 212° per hour. The total heating surface of the bagasse boilers being 17520 sq. ft. we have $\frac{85500}{17520} = 5$ pounds of water from and at 212° per sq. ft. of heating surface per hour. This is evidently above normal. The use of oil, therefore, with boilers deficient in heating surface for bagasse alone, can only aggravate the overloading.

In nearly all cases where oil burners were started with bagasse already burning, the per cent excess air was found to decrease. This was no doubt due to the fact that the quantity of combustion in the furnace was increased without increasing the quantity of air supplied.

FORMS AND TYPES OF FURNACES.

The data from the tests seems to throw little light upon this matter as far as combustion is concerned, though the opportunities afforded for comparison of the different types through general observation were considerable. It is not difficult to select the furnaces which were doing the best work by examination of the data in the tables, but the characteristics distinguishing these from the less efficient furnaces were, in the main, those of proportions of heating surface, grate surface, rate of combustion, air supply, etc., rather than of form and type. Furnaces A_1, Fig. I; E_1, Fig. V; G_2. Fig. I; J_1, Fig. VIII; M_1, Fig. XI; N_1, Fig. XIII; O_1, Fig. IX; P_1 and P_2, Fig. X; S_1, Fig. XV; T_1, Fig. XVI; V_1 and V_2, Fig. XV and W_1, Fig. XVIII, judging from the furnace temperatures and flue gas analyses, also from general observation, were burning fuel more efficiently than the average. As stated above, however, much of this is due to proportions rather than type and form.

The general requirements of a good bagasse burning furnace were discussed on pages .. to .., the essentials being a combustion chamber as completely enclosed within brick walls as possible and large enough to burn the gases; means for mixing the air and products, and the completion of their combustion before they reach the heating surface. It is evident that the oven furnace may best provide for all of these with the possible exception of the mixing of the products.

The oven furnace shown in Fig. I provides well for mixing the gases by means of the restricted passage from the oven (bottle neck). Air entering through the feed hopper can hardly pass through without mixing thoroughly with the products. This prevents the cooling of stratas of unburned gases near the top of the furnace below the burning temperature. This furnace also fulfills the requirements as to volume of combustion chamber and the locality at which combustion takes place.

The furnaces shown in Figures IV, VI, VII, VIII, IX, X, XII, XVI, all of the dutch oven type, fulfill the requirements named above except that there is no special arrangement for mixing the products as they leave the oven except the restricted passage. In all these furunaces there is danger, especially with natural draft, of stratas of cold air at the top of the furnace causing the gases there to be cooled below the burning temperature by the cold air coming in through the hopper. This could be remedied by placing a baffle plate similar in form and situation to that at the top of the furnace in Fig. XIV. This gives the current of air from the hopper a direction at right angles to that of the gases from the fuel bed, which naturally facilitates their mixture, preventing stratas. The form shown in Fig. IX has some advantage over the others named in this respect. In all of these, in the opinion of the writer, the form back of the bridge wall makes little difference from the economic point of view, though some are more convenient for handling the accumulations of soot and ashes than others.

The furnaces shown in Figures II, III, XIII, and XVII, in all of which the fuel is burned directly under horizontal return tubular boilers, do not fully meet the requirements stated above in that there is in most of them relatively small combustion chambers and which, instead of being entirely surrounded by fire brick walls, have for their top, metal water cooled surfaces, the low temperature of which, with the stratas of cool air, from the feed hoppers, may cause a portion of the gases to remain unburned.. It should be noted that the furnace shown in Fig. XVII differs from the others of its class in that there is an unusually great depth of combustion chamber, the distance from the grate to the boiler being 8 feet, whereas this distance in the others is from 4 feet to 4 feet and a half. This is undoubtedly a superior arrangement, as the observations taken during the tests upon it show. The designer of this furnace, who also operates it, states that in his opinion the distance mentioned could well be increased to 10 feet. It will be seen also that this boiler has three passes for the products of combustion instead of the usual two.

In Fig. V we have a furnace of the hearth type which fulfills well the requirements as to size of combustion chamber, the height being 8'—8''. This is a good furnace and one of comparatively simple construction. It will be noted that the distance from the top of the bridge wall to the boiler is only 12'', a smaller distance than is usual, which, within reasonable limits, is of advantage in mixing the gases.

The furnace shown in Fig. XI is similar to that of Fig. V, except that the air is supplied through hollow blast grate bars at the ground level, in addition to that through the tuyeres at the side and back of the furnace. This furnace gave a very high furnace temperature, the front casting being at times red hot. The result of this was the cracking of this casting in many places.

In Fig. XIV we have the step grate form of the dutch oven furnace. Air is supplied through the spaces between the bars forming the steps and through four tuyeres C from the duct B. which is open to the atmosphere at the ends. In this manner air from two directions at right angles to each other is supplied, thus bringing about good mixing. The object of the baffle plate at the top has already been discussed. The angle of the grate is such as to cause the bagasse to roll downward just fast enough to keep the steps and the grates at the bottom just covered and without piling up on the latter. This furnace is very sensitive and seems to require, at least with bagasse having much moisture, much attention, otherwise the fuel does not burn evenly upon the grate, piling in places and burning through in large holes at others, which is, of course, very prejudicial to efficient combustion. Furnaces of this type were tested at factories R and V, that at factory R doing much better because of the better bagasse and more even supply to the hopper. This type of furnace originated and has been very successful in Hawaii, where, however, unusually good mill work is done and where the moisture in the bagasse is quite low. It is to be hoped that by changes in the length of the drying plate at the upper end of the grate or in the angle of the grate better success may be reached with bagasse of high moisture.

Fig. XV shows the Cook furnace, which is of the hearth type. Bagasse falls into the retort B and air is supplied to it from the brick chamber A through tuyeres, under pressure. The products rise and divide into two streams, which supply heat to two Babcock & Wilcox boilers. This furnace gives excellent results, though it is very expensive to build and has so far been applied to the B. & W. boiler only. It is particularly well arranged for complete combustion of the products before they reach the heating surface, and for good mixing. The furnace is entirely closed, all air being supplied by the blower, so that there is little surplus air, the result being very high temperatures, as shown by the tests. There being no metal grates and little iron in the furnaces, these high temperatures are well withstood.

Fig. XVI shows an unusual form in that the grate is round. The air supply is by natural draft only, which was sufficient to burn about 170 pounds of bagasse per sq. ft. of grate per hour. The circular grate tends to give a uniform thickness of fuel bed and is convenient for cleaning out clinkers, as there are three fire doors at angles of 120°. The long, downward-inclined passage between furnace and boiler makes an admirable mixing device. Very high temperatures and little air excess were found in this furnace.

In Fig. XVIII we have a very superior furnace in connection with a Babcock & Wilcox boiler, the air supply being pre-heated by the flue gases on its way from the blower to the furnace. The air passes to the furnace through tuyeres, as shown in the sketch. This furnace, in addition to the other requirements, has an excellent mixing device in a baffle plate which deflects the gases and air downward as they leave the fuel chamber, the sharp turn given at the end of this plate insuring a thorough mixture. The gases may be seen to burst into flame as they pass this point, where they mix with the air coming through the feed hopper. Very high temperatures and small air excess were also found in this furnace.

Finally, with reference to the form and type of furnaces, the observations made, as well as the data gathered, show that a great deal depends upon the intelligence with which a furnace is operated, as well as upon the proportions, and that most any type, if well designed and operated, will give good results.

SUMMARY OF CONCLUSIONS.

An equivalent evaporation of 2¼ pounds of water per pound of bagasse as fired with an overload of 24% was found in the evaporation test.

The heat value of dry bagasse per pound varies within very small limits, the average being 8375 B. T. U. This difference in heat value seems to be due principally to the difference in ash contained.

On account of the porous, air-containing quality of bagasse there is seldom a formation of carbon dioxide in bagasse furnaces. The problem, therefore, seems to be the reduction of air excess.

A flue gas analysis with an air excess low enough to be considered good if coming from a coal furnace may not be considered so for bagasse, as the air excess may be lower for the latter, 50% excess, or less, being sufficient.

The sum of the flue gas components, $CO_2 + O + CO$, on account of other constituents contained, often falls considerably below the theoretical 21.

The flue gas analyses with the Orsat apparatus do not seem to show anything as to any differences in combustion taking place in ordinary and dutch oven furnaces.

The rate of combustion in the tests varied from 44 to 197.

The per cent of excess air varies inversely with the rate of combustion.

The best results were obtained with high rates of combustion. The rate should be at least 100, though the best results came with rates higher than this.

With large rates of combustion the furnace temperatures are higher, the air excess less and with other things equal the stack temperature is less.

Higher furnace temperatures and better combustion results with deep fuel beds, even at the edges.

The rate of combustion can be made as desired (within reasonable limits) provided the proper quantity and pressure of air is supplied.

The pressure of the air supplied by blowers was found to vary widely in different plants, being from 1.1 to 10.1 inches of water.

In combined natural and forced draft plants a relatively small part of the air is supplied by the blower. Data from the tests shows 7.5 to 68.4 cu. ft. per pound of dry bagasse, average 33.4 cu. ft.

Flue dampers can be used to advantage, especially with rates of combustion below that for which a furnace is designed, in reducing the loss due to excess air.

Large excess of air causes high stack temperatures.

"Balanced furnace draft" results in lower stack temperatures, higher furnace temperatures and better mixture of the products.

Abnormally high stack temperatures were found in a majority of the Louisiana houses, sometimes as high as 700° and above.

High stack temperatures do not result from combustion of CO to CO_2 in bagasse burning, but, in most cases, from overloaded heating surface.

In many cases 6 or more pounds of water are evaporated from and at 212° per sq. ft. of heating surface per hour.

Not more than 1.5 pounds of bagasse should be burned under ordinary conditions per sq. ft. of heating surface per hour.

The boiler capacities per ton of cane per 24 hours are less in Louisiana houses than in Cuba or Hawaii.

Not less than 1.5 boiler horse power should be provided per ton of cane per 24 hours.

The burning of oil together with bagasse may result in higher furnace temperatures than with either of them alone, also in better combustion, if the furnace is of proper design, but care must be taken to prevent overloading the heating surface.

A good working furnace depends more upon the proportion of heating surface to grate surface, rate of combustion and other matters of design and operation than upon the form or type.

Higher temperatures are produced in the separate oven than in the ordinary grate type.

In the ordinary grate type much of the advantage of the oven type may be secured by increasing the distance from grate to boiler.

Part of La. Bulletin No. 118. August, 1909.

Agricultural Experiment Stations

OF THE

Louisiana State University and A. & M. College

BATON ROUGE

CORN

By W. R. Dodson and V. L. Roy.

BATON ROUGE
The New Advocate, Official Journal
1909

CORN.

Selecting, Grading, Preserving Seed Corn, Preparing Exhibits, Rules and Regulations for Judging.

W. R. DODSON AND V. L. ROY,

INTRODUCTORY STATEMENT.

Bulletin No. 118 will cover the general subject of corn production in Louisiana. The preparation of the manuscript in full has been delayed, and it has been found to be impossible to get out the complete bulletin before the harvesting of the present crop. It was therefore decided that that portion of the bulletin dealing with selection of seed corn and the preparation of exhibits should be issued, so as to be of service now, as this work for the present year must be done in the near future. The complete bulletin will discuss also the questions of preparation of soil, planting, fertilizing and cultivating the crop, and the results of variety tests extending over a number of years.

Good seed corn is as important as good soil or proper cultivation and fertilization. It is quite reasonable to hope that the average yield of corn in Louisiana can be greatly increased, if the proper interest can be awakened in seed breeding and selection. Such interest is being manifested by our best farmers and planters already, and the time is opportune for the development of enterprises along these lines. The following suggestions and explanations should be helpful to all progressive corn growers, whether school boys or practical farmers, who have not previously made a thorough study of corn. It is not expected that every farmer will become a corn breeder, but there should be enough good seed produced in each community to supply every field with well-bred seed.

SELECTION OF SEED CORN.

The experiment stations of Alabama, Arkansas, Oklahoma, Texas, Maryland and Louisiana have all found home-grown seed superior to northern-grown seed. The best corn growers of Texas, and the corn specialists of the Agricultural College of Texas, all recommend home-grown seed corn. It pays the producer to raise good seed for sale, and it pays the purchaser to give what the seed is worth. Seed corn put on the market as well-bred seed is sometimes of inferior quality. Seed well suited for a given soil and climate may be poorly suited for a locality with entirely different soil and climate. It is therefore prudent to purchase only from a man who is known to be reliable, and whose methods of selection and breeding are approved by good breeders. It is likewise the part of wisdom to secure strains of corn that are known to do well in soil and climate similar to that in which the crop is to be planted.

It is desirable to purchase seed corn in the ear. Therefore, whether a man is producer or purchaser, it is important that he be able to judge of the qualities of good corn, so far as they are shown in the ear. The one that must make the improvement, however, is the grower. He must know the parentage of the ears. The stalk is the mother parent; therefore *selections should begin in the field.*

The characters of the stalk are as strongly hereditary as are the characters of the ear. The first step therefore in improving corn in any given locality is to select in the field *strong stalks, free of suckers, with well-developed leaves and plenty of brace roots; ears not too high* from the ground, with a moderately *long shank* and a *heavy shuck,* completely *drawn over the end of the ear.* Other characters may also be considered, but these are the more important. The tendency to sucker is hereditary, and suckers are undesirable. The leaves manufacture the materials that build the stalk and ear, and should be broad and strong. Strong stalks and brace roots are of great value in resisting storms. Ears that stand too high from the ground, above the middle of the stalk, not only make the stalk top-heavy and liable to prostration by winds, but indicate later maturity, and greater inconvenience in gathering. In rich land and with the large varieties of corn about five or five and a half feet from the ground should be the extreme height of ears.

It is the judgment of the writer that over a series of years the best results will be secured by having the stalks come into silk as near all at the same time as possible. An approximate idea of *earliness or lateness,* relatively, can be had by counting the joints in the stalk between the ear and the ground—the larger number of joints indicating a later ear, with a given strain of corn. A long shank is desired in Louisiana because it affords better weather protection. The ear droops at maturity and the most favorable watershed is provided. A heavy shuck is a protection against birds and grain weevils, both serious enemies to corn throughout the state.

The softer the corn the more important is a heavy shuck, that protrudes well to completely cover the end of the ear.

The size of the ear is an important consideration, since we frequently have an abundance of rain about the time that corn matures. Excessively large ears dry out slowly and are apt to become moldy, causing injury to the grain for either feed or seed. A moderately long ear without excessive thickness is much to be desired. The number of ears per stalk that give the best results is a question yet unsettled. Presuming that we are not dealing with any of the prolific types of corn, it is the judgment of the writer that a crop of corn with sixty to seventy per cent of the stalks bearing one well-developed ear, and the remainder two ears, will give more satisfactory results under average conditions than can be secured by trying to establish two ears on every stalk. In other words, the number of ears in large types of corn should not be a primary consideration. Others may think differently on this point. It is my judgment, after much consideration, that if one desires more than one ear per stalk on the majority of stalks, it would be better to go at once to some of the established varieties of prolific corn, and improve that to suit his community conditions. The yield of the best prolific corns compares favorably with the large-eared varieties. However, the prolific corns have small ears, and somewhat more labor is required to handle them. Some of the prolific corns are deservingly popular.

Marking selected stalks may be accomplished in various ways. A bright colored rag string may be tied to the ear to call attention to it in the general gathering, when it can be thrown into a special receptacle provided for the purpose in the wagon. Some prefer to gather these ears in advance of the general crop. The quantity to be selected should be sufficient to allow liberal culling when grading the ears after the shuck has been removed. Rules governing the selection of choice ears are practically the same as selecting ears for exhibition purposes, which are given later.

The factors thus far considered are apparent on examination of ears and stalk. A most important factor is the ability of the ear to give large yields the following year.

Methods of determining the producing power of different ears is much simpler and easier than most corn growers think it to be, and the producing power much more variable than they can realize without a demonstration. Various experiment stations have shown that there may be a difference of more than a hundred per cent in the yields secured from ears of similar characters graded on the score card. In a later circular this question will be fully discussed.

STORING AND PRESERVING SEED CORN.

Having selected corn for seed, no pains should be spared to have it well cared for during the winter. Protection from rats, corn weevils and grain moths is most important. Of course, the seed should be kept in a dry place, where moderate ventilation can be had. Carbon bisulphide ("high life") can be used to destroy weevils and moths, and if the grain is not subjected to the vapors more than 24 hours, the grain will not be injured. Use one pound of carbon bisulphide for each hundred bushels of corn. Put the corn in a tight crib or large box, and pour the bisulphide in a small dish or open can and set the dish or can on top of the corn and cover the box or close the crib, or cover the corn with tarpaulins. The fluid rapidly vaporizes. The vapors of the poison are heavier than air and therefore penetrate to the bottom of the corn. As the bisulphide is explosive, great care should be taken to have no fire near. The treatment should be repeated if weevils or moths reappear. If the treatment is prolonged more than 24 hours, germination of the corn may be impaired. Boxes, or even small cribs, may be made sufficiently tight by pasting heavy paper over all cracks. A tight floor is necessary for good results.

The final selection of the planting ears should be governed by practically the same rules that govern judging exhibits, and are given under that head.

Discarding butts and tips is an old practice of corn growers. In recent years many experiments have been carried on in which the vitality and producing power of grains on butts and tips, as compared to that of the remainder of the ear, have been tested. The results show that the importance of discarding these grains have been overestimated. The variation in size of the grain, producing irregularities in the work of the planter is somewhat objectionable. Practically the entire ear should be used.

Color in corn is of little importance when corn is to be used for stock feed. White corns are preferred for meal in the southern states.

Hardness of grain is a character of considerable importance in selecting corn for Louisiana. If the corn can be ground before it is fed, very hard corn is desirable, as it is more resistant to injury by the weevils. Soft corn can be protected, however, after it is housed. There is no way of lessening damage by weevils and moths in the field, except by selection for heavy shuck and hard grain. No one variety of corn can be said to be best for all parts of Louisiana. There is a long list of good varieties. If a new variety is exhibited, evidence must be shown that it is entitled to rank as a commercial variety.

SELECTING CORN FOR AN EXHIBIT.

A good way to select an exhibit is to place a large number of good shucked ears on a table of convenient height, with all tips pointing one way; select an ear that comes very near to the ideal ear of the variety, and, holding it in one hand for constant comparison, discard with the other hand all ears that are distinctly unlike the model ear in size, shape and general characters. Bring together the remaining ears and examine them closely as to points counted on the *score card* explained hereafter.

VARIETY STANDARDS.

Every variety of high-bred corn properly recognized in the United States has a standard to which the individual ears must conform. This standard covers the following points: *shape, length, and circumference of ear; condition, color, indentation and shape of kernel; number, space and arrangement of rows; filling out of butts and tips; size of shank; size and color of cob;* and *per cent of grain to ear.* To illustrate: the Illinois standard for Boone county white corn is as follows: Ear shape, cylindrical; length, 10 inches; circumference, 7.5 inches; kernel condition, firm and upright; color, pearl white; indentation, rough; shape, medium wedge; number of rows, 16-22; space, medium; arrangement, in pairs; butt, moderately rounded, compressed; tip, regular rows of kernels; size of shank, medium; of cob, medium; color of cob, white; per cent of corn, 88.

The standard of a given variety is based upon the study of typical ears by experienced corn men; and it seeks to define accurately those traits which are bred into the variety and which enter into the merits of an ear of corn. By this means, we eliminate the possibility of a judge placing undue emphasis on characters that please or displease him personally; and a uniform standard is established as a guide to judges throughout a section or state.

The Illinois Corn Growers' Association has adopted the following standards as to length and circumference of ear and proportion of corn to cob for the different varieties recognized by the Association:

Variety—	Length in inches.	Circumference in inches.	Proportion of corn to ear.
Reid's Yellow Dent.......	10-11	7.25-7.75	88%
Leaming	10-11	7.25-7.75	88
White Superior...........	10-11	7.25-7.75	88
Boone County White......	10-11	7.5-8.0	88
Riley's Favorite..........	9-10	7-7.75	90
Golden Eagle.............	9-10	7.25-7.75	90
Silver Mine...............	9-10	7-7.5	90

Some varieties of corn that will be on exhibition at the State Fair and at parish fairs will, no doubt, have no adopted standard. For instance, we know of no standard for Yellow Creole. This corn, so far as we know, is not grown in states where exhibits are carefully scored and variety standards are established. In judging such varieties, a general standard is ordinarily used. But, in such cases arising in Louisiana at this time, arbitrary standards will have to be adopted by the scorer, until such time as some proper authority may determine upon the specific standard of the variety. It is assumed that it will be fair to formulate such temporary standards from the opinions of the growers of each variety, taking an average of opinions as to those points that constitute the score card.

The stipulation of rule 4 regarding a red cob and white grain, should not deter any one from making an exhibit of white corn that has a red cob as a character of the strain. No doubt a means will be found that will be equitable and just to provide for the contingency, should there be close competition on other points between a red cob and a white cob strain.

THE SCORE CARD.

This is a device adopted to aid in placing a just estimate upon those points or characteristics which determine the value of an ear of corn, and to guide the scorer in arriving at the relative merits of different varieties. The score card is not intended to be used with mathematical accuracy, except where the points to be cut are fixed by the rules for judging, as explained below. In all other cases, the number of points to be given or cut lies with the scorer, and the score is reliable in proportion to the accuracy and intelligence of the scorer's judgment. Corn judging by use of the score card is a comparative and not an individual matter, and the scorer should endeavor to place a fair value for each sample or exhibit upon the several points constituting the score card.

The late Orange Judd, editor of the Orange Judd Farmer, and leading publisher of agricultural literature in America, was the first to formulate a score card for corn. The Illinois Corn Growers' Association was the first organization that adopted a corn score card, and today all corn associations have score cards. Since Louisiana has no such association, the authorities of the State Fair have adopted for temporary use the score card of the Illinois Association. When our corn growers assemble and organize, they will, no doubt, take up the matter of formulating a score card for Louisiana, with such modifications of the one temporarily used as may be deemed advisable.

Following is the corn score card temporarily adopted:

THE CORN SCORE CARD.

Revised January 27, 1908.

		Perfect Score.
1.	Uniformity of exhibit	5
2.	Shape of ear	10
3.	Length of ear	10
4.	Circumference of ear	5
5.	Tips of ear	5
6.	Butts of ear	5
7.	Kernel uniformity	5
8.	Kernel shape	5
9.	Color in grain and cob	10
10.	Space between rows	5
11.	Space between kernels at cob	5
12.	Vitality or seed condition	10
13.	Trueness to type	10
14.	Proportion of shelled corn to ear	10
	Total	100

Each entry shall consist of ten ears of corn.

Following is a brief explanation of the several points which constitute the score:

1. *Uniformity of Exhibit* (5 Points).—The several ears of the sample or exhibit should be uniform in shape, length, circumference, color, indentation, etc.; but the *kind* of shape is not to be considered at this time. Arrange the exhibit, placing the ears of uniform appearance together, and grade according to the amount and extent of variation. If eight ears are uniform, and two are different in type, score 4.

2. *Shape of Ear* (10 Points).—This should conform to the variety shape; the ears should be true to the type. A sample of Yellow Creole, for instance, should be tapering, while Shaw's

Improved should be cylindrical. The rows should be straight and regular, and should not turn to the right or left. Cut one point for each ear of irregular or poor shape.

3. *Length of Ear* (10 Points).—In length, an exhibit should conform with the standard of the variety. Add together the excess or deficiency in length of all ears, and cut one point for every inch thus obtained. In getting the length of an ear, measure from extreme tip to extreme butt. Should the deficiency in length exceed ten inches, cut two points for each additional inch.

4. *Circumference of Ear* (5 Points).—The circumference varies with the standards for different varieties. It should be measured at one-third the distance from the butt to the tip. The excess or deficiency of all ears not conforming with the standard should be added together, and a cut of one point made for every two inches thus obtained. To measure the circumference take the ear in one hand, and, holding the end of the tape line at the right point with the index finger, wrap the tape and note the measurement.

5. *Tips of Ears* (5 Points).—Ears with perfect tips should be covered with straight rows of kernels arranged in regular order. The tip should not be pointed, double or flat, but of regular oval shape. An exposed tip indicates that some of the tip silk matured too late to receive pollen. Kernels of irregular shape or undue size at the tip are due to imperfect pollination and to an effort of the fertilized kernels to spread out and cover the entire tip. A tip exposed one inch should be cut one-half point, and a proportional cut should be made for less exposure. Cuts should also be made for irregular kernels at the tip, the grading being proportional to the degree of irregularity.

6. *Butts of Ears* (5 Points).—As in the case of the tip, the kernels at the butt of the ear should extend in regular order over the butt and around the shank, leaving a deep depression when the latter is removed. If the butt is not fully covered the shank is likely to be large and unduly strong, which adds to the labor of husking; on the other hand, the kernels should not so crowd around the shank as to interfere with its proper development and weaken it. Exposed or swollen butts, depressed or flat butts, and butts with kernels of irregular shape should

be cut from one-tenth to one-half point; but it should be borne in mind that the depression in the butt differs with the variety, being larger in the large-eared breeds.

7. *Kernel Uniformity* (5 Points).—The shape of the kernel depends somewhat upon the variety, some being long, rather slender and wedge-shaped, others broad and flat; but the kernels of a sample should be uniform among themselves, particularly as to size, shape, indentation and color. The scorer should carefully distinguish between kernel uniformity and the next point, kernel shape. To examine the kernels of an ear, remove two grains at the middle of the ear. A cut of one-half point should be made for each ear with kernels distinctly lacking uniformity.

8. *Kernel Shape* (5 Points).—While the shape of the kernel varies with the variety, it should in general be deep and wedge-shaped, with straight edges. This shape enables a given cob to carry the greatest amount of grain. The kernel should be full at the tip and have a large, well-developed germ. Judge the shape of the kernels, whether true to type from the 20 kernels removed under 7 above, and score accordingly.

9. *Color in Grain and Cob* (10 Points).—The color of the kernels should be true to type. The presence of yellow kernels on a white ear, or of white kernels on a yellow ear, indicates careless selection or faulty breeding; so does the mixture of tints, as when a white ear has yellow tinted grains. For one or two mixed kernels, cut one-fourth point; for three or four, cut one-half point; for five, cut three-fourths of a point; and for six or more mixed kernels make a cut of a full point. Missing kernels are cut on the same basis, on the assumption that they were mixed. The color of the cob should be true to the variety. Shades of color in grain or cob different from the variety characteristics or differences in shade in an exhibit, should be graded in accordance with the amount of such differences.

10. *Space Between Rows* (5 Points).—The furrow between the tops of the rows of kernels is lost space, and it is due to circular or rounded crowns in the kernels. Such spaces between rows result in a reduction in the percentage of grain to ear. A cut of one-half point should be made for each ear

with spaces between rows of one-sixteenth of an inch or more.

11. *Space Between Kernels at Cob* (5 Points).—This refers to the space at the cob between the tips of the kernels in a row. To examine this, take out several kernels at the middle of the ear. Such spaces indicate a grain of inferior constitution and poor food value.

12. *Vitality of Seed Condition* (10 Points).—Each ear of the exhibit should offer evidences of being ripe, dry, sound, in good seed condition, free from injury or diseases, and bright in color. The germ should be large and well developed, bright and healthy in appearance, and capable of producing a robust and vigorous plant. The germination test is the only absolute means at our command of judging the vitality of a sample of corn.

13. *Trueness to Type* (10 points).—An exhibit is true to type if it possesses the recognized characteristics of the variety. This means that each ear should conform to the type in its size, shape and color, and in the size, shape and indentation of its kernels. The more highly bred a variety of corn is, the more fixed are its characteristics, and hence the more certain is it to produce offsprings true to type. The scoring here should be on the basis of the number of ears true to the variety; and where an ear varies from the type a cut should be made based on the amount of such variation.

14. *Proportion of Shelled Corn to Ear* (10 Points).—This is determined as follows: Use each alternate ear of the exhibit; weigh the five ears; shell the grain and weigh the cobs; deduct the weight of the five cobs from the weight of the five ears; and divide the difference thus obtained by the total weight of the five ears. The difference above gives the weight of grain, and the quotient is the percentage proportion of grain. A cut of one point should be made for each per cent the sample falls short of the standard.

The student of corn judging should learn the score card and understand in detail the meaning of each point listed on the card. He should also know how many points or what parts of points should be cut from the total for defects and variations, as has been explained above. The score is made on the basis of 100 per cent, the total number of points for a perfect ear aggregating 100. Nothing but practice and study will enable the student to attain any degree of competency in scoring corn. Samples of ten ears should be obtained of as many varieties as possible, and these should be used in the practical work of scoring. The student should score the same sample repeatedly, and then compare the different scores.

DIRECTIONS FOR PREPARING AND SHIPPING EXHIBITS.

Having selected the ten ears that are to form the exhibit of each variety, the exhibitor should groom the ear thoroughly by removing all husk, silks and shank. Parts of the shank remaining on the ear should be carefully removed with a knife, leaving a well-rounded depression. Care should be taken not to mutilate the ear or remove kernels, as missing grains are to be considered as mixed and cuts are made accordingly.

All exhibits to be entered at the State Fair at Shreveport Nov. 1-6, 1909, should be shipped prepaid so as to reach destination not later than Oct. 31. Each ear should be securely wrapped and tied. The ten ears of the exhibit should then be wrapped together, tied and numbered, and the name of the variety plainly written. To prevent the shelling of any grain from the ears, each exhibit should be carefully packed in straw or excelsior. The name of the sender should be plainly written on the outside of the package or box; and, in the case of corn clubs, a list should be sent by the superintendent or teacher, addressed to the Secretary of the State Fair, Shreveport, La., and containing the name and number of each exhibition, corresponding to the numbers attached to the several exhibits.

The name of the variety must accompany the exhibit, so the standard can be properly assigned, by which to judge the exhibit.

Where it is possible, the yield per acre of the corn from which the exhibit was selected should be given as a part of the data accompanying the exhibit. While not required as a condition of the award, the general value of the exhibit would be greatly enhanced by a statement of the main facts regarding the production of the corn exhibited.

PREMIUMS FOR BEST EXHIBITS.

The State Board of Agriculture and Immigration offers the following premiums in each parish holding a parish fair; premiums to be awarded by a committee appointed by the parish fair association with the approval of the Commissioner of Agriculture and Immigration:

Best Bushel of white corn on ear	$5.00
Best bushel of yellow corn on ear	3.00
Best bushel of flint corn on ear	2.00
First premium, public school corn club, individual exhibit	6.00
Second premium, public school corn club, individual exhibit	4.00
Third premium, public school corn club, individual exhibit	3.00
First premium, best essay on preparaton of soil and corn culture by members of the Corn Club between the ages of twelve and sixteen years	5.00
Second premium, best essay on preparation of soil and corn culture by members of the Corn Club between the ages of twelve and sixteen years	3.00
Third premium, best essay on preparation of soil and corn culture by members of the Corn Club between the ages of twelve and sixteen years	2.00

Certificates with State seal will be issued by the Department to the winners of the first premiums awarded by the State.

The following is taken from the catalogue of the State Fair:

CLASS 69.

CORN EXHIBIT.

Each entry shall consist of ten ears of corn.

In competing for best individual ears, Nos. 814, 815, 816, 817, separate entry must be made, and entry tag attached to ear entered for competition.

In the competition for flint corn, these corns should be of sufficient size to be worthy of perpetuation for feed production, otherwise no premiums will be paid.

		First	Second	Third
810	White Dent, 10 ears	$50.00	$25.00	$15.00
811	Yellow Dent, 10 ears	50.00	25.00	15.00
812	White Flint, 10 ears	15.00	10.00	5.00
813	Yellow Flint, 10 ears	15.00	10.00	5.00
814	White Dent, 1 ear	7.50	2.50	
815	Yellow Dent, 1 ear	7.50	2.50	
816	White Flint, 1 ear	5.00	2.50	
817	Yellow Flint, 1 ear	5.00	2.50	

SWEEPSTAKES.

818	Only first prize winners eligible	$25.00

OTHER CORN.

819	Pop Corn, 10 ears	$ 3.00	$ 2.00	$ 1.00
820	Sugar Corn, 10 ears	5.00	2.50	1.00

BOYS' CORN CONTEST.

Prof. V. L. Roy, Baton Rouge, Superintendent.

All entries close Saturday, October 23, 1909.

The following prizes are offered to the Boys' Corn Clubs of the State and to their members. All clubs, whether parish or school clubs, are invited to enter the contests. Exhibits should be sent in not later than October 31, by each teacher or by the club manager in the case of parish clubs. The contests are open only to boys under 18 years of age. Correspondence with club managers is invited in order that every club in Louisiana may exhibit at the State Fair. The rules governing these contests shall be the same as for other corn in this class, except that there will be no distinction as to varieties. Ten ears of corn shall constitute an individual exhibit for each boy, and the parishes are requested to send not less than ten exhibits nor more than thirty. The prizes will be awarded according to grade and a large exhibit will not aid in winning the sweepstakes. Each ear of an individual exhibit should be wrapped separately, and then the exhibit of ten ears securely wrapped, tied and numbered. Send list of boys numbered to identify the exhibits. The Fair Association will gladly furnish a season ticket to not more than three boys or two girls from each parish, upon presentation of certificate from the parish superintendent, for the purpose of entering the judging contest or for looking after exhibits.

BOYS' CORN CLUB.

		First	Second	Third
822	General exhibit of corn by a boys' corn club	$30.00	$20.00	$10.00

To compete for these premiums there must be not less than ten exhibits from a corn club, and each exhibit to have 10 ears, and the excellence is to be considered on the whole exhibit.

		First	Second	Third	Fourth
823	Exhibit of 10 ears of corn by an individual member of a boys' corn club	$20.00	$15.00	$10.00	$5.00

		First	Second	Third	Fourth	Fifth
824	Best and most perfect ear of corn shown by any member of a boys' corn club	$10.00	$6.00	$4.00	$2.00	$1.00

CONGRESSIONAL DISTRICTS.

		First	Second
825	For the best general exhibit of corn by a boys' corn club (excluding the winners in the sweepstakes' prizes) in the First Congressional District	$15.00	$10.00
826	Second Congressional District	15.00	10.00
827	Third Congressional District	15.00	10.00
828	Fourth Congressional District	15.00	10.00
829	Fifth Congressional District	15.00	10.00
830	Sixth Congressional District	15.00	10.00
831	Seventh Congressional District	15.00	10.00

The parishes in the several districts are as follows:

First District—Orleans, Plaquemines, St. Bernard.

Second District—Jefferson, St. Charles, St. James, St. John.

Third District—Assumption, Iberia, Lafayette, Lafourche, St. Martin, St. Mary, Terrebonne, Vermilion.

Fourth District—Bienville, Bossier, Caddo, DeSoto, Natchitoches, Red River, Sabine, Webster, Winn.

Fifth District—Caldwell, Catahoula, Claiborne, Concordia, East Carroll, Franklin, Jackson, Lincoln, Madison, Morehouse, Ouachita, Richland, Tensas, Union, West Carroll.

Sixth District—Ascension, East Baton Rouge, East Feliciana, Iberville, Livingston, Pointe Coupee, St. Helena, St. Tammany, Tangipahoa, Washington, West Baton Rouge, West Feliciana.

Seventh District—Acadia, Avoyelles, Calcasieu, Cameron, Grant, Rapides, St. Landry, Vernon.

Provided that twelve or more duly accredited boys representing the corn clubs of the State, not more than three from any parish, are present to contest, the following prizes will be offered for greatest ability in corn judging: First, $15.00; second, $10.00; third, $5.00.

BOYS' CORN CONTEST.

Other Than Members of Corn Clubs.

		First.	Second.
832	To the boy selecting the best 10 ears from his father's corn	$5.00	$2.50

CORN GROWERS' ASSOCIATION.

Professor W. R. Dodson of Baton Rouge, La., desires that a Louisiana Corn Growers' Association be organized, and a meeting is hereby called, to be held in the Agricultural Hall, Wednesday, November 3, 1909, at 10 o'clock a. m. This meeting will be held during the State Fair, and it is earnestly requested that all interested in this movement be on hand promptly at that hour, at which time the organization will be perfected, and officers elected.

Louisiana Bulletin No. 119. April, 1910.

Agricultural Experiment Station

OF THE

Louisiana State University
and A. & M. College,

BATON ROUGE.

THE BEAN ANTHRACNOSE

BY

C. W. EDGERTON,
Plant Pathologist.

BATON ROUGE
The New Advocate, Official Journal
1910

AGRIC. [illegible] LIBRARY
LOUISIANA STATE UNIVERSITY

Louisiana State University and A. & M. College

Louisiana State Board of Agriculture and Immigration

EX-OFFICIO.

GOVERNOR JARED Y. SANDERS, *President.*
HENRY L. FUQUA, *Vice-President of Board of Supervisors.*
CHAS. SCHULER, *Commissioner of Agriculture and Immigration.*
THOMAS D. BOYD, *President State University.*
W. R. DODSON, *Director Experiment Stations.*

MEMBERS.

Henry Gerac, Lafayette.
John T. Cole, Monroe.
John J. Henderson, Lagan.
R. E. Thompson, Wilson.
Jeff D. Marks, Crowley.

STATION STAFF.

W. R. DODSON, A. B., B. S., Director, Baton Rouge.
HAMILTON P. AGEE, B. S., Assistant Director, Audubon Park, New Orleans.
S. E. McCLENDON, B. S., Assistant Director, Calhoun.
FRIEND C. QUEREAU, B. S., Ass't Director Rice Exp'ment Station, Crowley.
W. G. TAGGART, B. S., Assistant Chemist, Audubon Park, New Orleans.
WM. G. OWEN, B. S., Bacteriologist, Audubon Park, New Orleans.
J. K. McHUGH, Secretary and Stenographer, Audubon Park, New Orleans.
J. E. HALLIGAN, B. S., Chemist, Baton Rouge.
H. L. GREEN, B. S., Assistant Chemist, Baton Rouge.
A. P. KERR, B. S., Assistant Chemist, Baton Rouge.
R. BAUS, B. S., Assistant Chemist, Baton Rouge.
R. G. FULLER, B. S., Assistant Chemist, Baton Rouge.
R. G. TILLERY, B. S., Assistant Chemist, Baton Rouge.
P. H. DOHERTY, B. S., Assistant Chemist, Baton Rouge.
ROGER P. SWIRE, Treasurer, Baton Rouge.
J. B. GARRETT, B. S., Entomologist, Baton Rouge.
G. L. TIEBOUT, B. S., Horticulturist, Baton Rouge.
W. H. DALRYMPLE, M. R. C. V. S., Veterinarian, Baton Rouge.
C. W. EDGERTON, Ph. D., Plant Pathologist, Baton Rouge.
E. W. KERR, M. E., Professor Mechanical Engineering, Baton Rouge.
T. C. PAULSEN, B. S., M. D. C., Assistant Veterinarian and Bacteriologist.
J. T. TANNER, B. A., Secretary and Stenographer, Baton Rouge.
IVY WATSON, Farm Manager, Calhoun.
E. J. WATSON, Horticulturist, Calhoun.
SAM'L FRYE, in charge of Dairy, Baton Rouge.
V. L. ROY, B. S., in charge of Boys' Demonstration Work.

THE BEAN ANTHRACNOSE.

By C. W. Edgerton.

While the acreage that is used for bean growing in Louisiana is not large, the crop is a very important one in certain sections of the state. Favored with a semi-tropical climate, Louisiana can grow wax or snap beans and have them on the northern markets in early May or even the last of April, about the same time, or even before our sister states of the north are ready to plant. This, as a rule, means very good returns for the trucker, if he is situated where the transportation facilities are good and if he is able to keep his crop free from spotting.

The sections most used for bean growing are those joining the Illinois Central Railroad in Tangipahoa Parish, the region in the vicinity of New Orleans, parts of Livingston, East Baton Rouge and Plaquemines parishes.

While all parts of the state doubtless produce enough for home consumption, most of the beans raised on a commercial basis, are grown in the above regions. Tangipahoa is well adapted for bean growing, having a favorable soil and transportation facilities of the best. Beans shipped from this region can be placed on the Chicago market in 36 hours. The loss in transit is generally small. During 1909 the loss due to beans spoiling in transit, of those shipped from Ponchatoula, was about two per cent; and this small loss could doubtless have been reduced with proper care in picking and crating.

It is difficult to estimate the total acreage of beans in the state. W. S. Keaghey estimates that there were 240 acres in the vicinity of Ponchatoula alone. Perhaps a thousand acres would be a fairly accurate estimate of the spring crop during 1909. And the fall crop would probably raise this estimate somewhat for the whole year.

The total yield for the Ponchatoula region was 20,000 bushels of green pods or an average of 83 bushels to the acre. The maximum yield was about 140 bushels. The average return, with the transportation charges subtracted, was eighty-five cents per two-thirds bushel crate or an average return per acre of $105. This is a very good return, considering that this represents only the spring crop and that the same ground is capable of producing another crop during the season.

The season of 1909, however, should be classed as a favorable one for bean growing. The weather conditions during the last part of April and the first part of May were excellent. There was practically no rain and the beans developed fast, and were in many cases almost free from spotting. During this dry spell, the greater part of the bean crop was picked and shipped. The beans that came on earlier and also those that came on later, however, formed under rainy and humid conditions and the loss from spotting was considerable. Years in which the pods develop during periods of very humid and wet weather give returns to the trucker, which are, to say the least, very discouraging. The pods spot, and of course become entirely unsalable. As a consequence, many truckers do not risk a very large acreage. If it were possible to eliminate the loss from the diseases, bean growing would rapidly become a more popular crop for the truck raiser.

The diseases to which beans are subject in Louisiana are as follows: Anthracnose, Blight, Rhizoctonia Rot, Sclerotium Wilt Disease, Cercospora Pod Spot, and Phyllosticta Leaf Spot. Of these the first five may be serious while the other two are of no importance from an economic standpoint. By far, the most serious of the troubles are the anthracnose and blight. As most of the work done at the Louisiana Station has been on the anthracnose, this alone will be treated in this bulletin; and as a popular bulletin was published on this subject in June, 1909 (Louisiana Bulletin No. 116), it has been thought best to treat the disease at this time in a technical manner only.

Before beginning the discussion of the disease, I wish to express my thanks to various people who have aided me in the investigation; especially to Mr. W. S. Keaghey of Ponchatoula for information in regard to bean growing and diseases; to Professor G. L. Tiebout, Horticulturist of the Station, for aid in carrying out the field work on the Station grounds; and to Professor H. H. Whetzel and Mr. M. F. Barrus of Cornell University for sending me a quantity of diseased and healthy seed for use in the investigation.

THE CAUSE AND DISTRIBUTION OF THE DISEASE.

The bean anthracnose has been known to botanists and horticulturists for about thirty-five years. It was first noticed in Popplesdorf in 1875 by Lindemuth. Whether it existed to any extent before that is unknown, but it is somewhat questionable, as it probably would have been noticed by some of the early botanists or horticulturists. Soon after the first notice of the trouble, it began to be a very important factor in bean raising. At present it is cosmopolitan in nature, being present in practially every country in the world. At the present time, there are but few diseases which are more familiar to plant pathologists and horticulturists than this. As it causes a large financial loss every year, it has been the subject of considerable study at various times by different workers.

The disease is due to the fungus, *Colletotrichum lindemuthianum.* At first it was named *Gloeosporium lindemuthianum,* but since the presence of setae in the fruiting postules was demonstrated, the former name has been mostly used. The disease appears as spots on all parts of the bean plant above the ground, and sometimes even extends a short distance below the surface of the ground on the stems. As the appearance of the disease on the different parts of the host plant is fairly familiar to botanists, I will only give a short description of it.

THE SPOTS ON THE PODS.

The spots on the pods are the ones most frequently noticed by the bean grower. The spots show first as very small dark colored places on the pods but they increase in size very rapidly, sometimes becoming a centimeter in diameter. Often also, different spots will coalesce and form very large lesions, these sometimes covering the greater part of the pod. The spots (Plate 1) are as a rule round or oval, but sometimes vary into irregular shapes. Soon after the spot is visible on the pod, it becomes darker in color and the tissue dries up and shrinks and as a result is depressed. The fully developed spot is considerably sunken, nearly black in color in the center, and generally surrounded by a reddish zone. Soon after the spot becomes shrunken, the acervuli or fruiting pustules begin to develop, and the surface takes on a pinkish color from the mucilaginous mass of spores formed. Also at this time, the spots are generally more or less slimy.

THE SPOTS ON LEAVES.

On the leaves, the disease appears almost wholly on the veins and petioles. The spots are generally seen on the under side of the leaf alone, due without doubt to the fact that the source of infection is generally from beneath. The affected veins become black in color and the larger ones somewhat sunken, similar in this respect to the spots on the pods. The fungus grows rapidly along the larger veins and also out on the smaller veinlets (Plate II). If the infection is severe, sometimes the leaf tissue dies between the infected veins, but normally in the field this seldom occurs. Often also, the disease attacks the small growing leaves causing them to become twisted and crinkled (Plate V, fig. I). This is due to the continued growth of the parenchymatous tissue of the leaf after the veins are dead.

While infection generally takes place in the field on the lower side of the leaf, the upper side is just as susceptible to the disease if the spores are present. Experiments were tried in the greenhouse to see if either side of the leaf was more easily attacked by the fungus. On some leaves, spores were sprayed on the under side with an atomizer, while on others, they were sprayed on the upper side. After the normal period of incubation, the spots appeared abundantly on all of the leaves, but only on the side on which they were inoculated. On the leaves sprayed on the under side, there developed typical anthracnose spots on the veins, taking some time for the disease to grow through the leaf so that it would show on the upper side. Leaves sprayed on the upper side, had the veins killed on the upper side alone, and the typical spots which normally appear on the lower side of the leaves were absent. The veins on the upper side did not take on the deep black appearance that is so often seen on the lower surface but were more brown in color; otherwise the spots were similar. From this we are forced to believe that the leaves are normally infected from the lower side, probably due to a considerable extent to the splashing up of the spores from the ground.

THE SPOTS ON THE STEMS.

On the stems, the spots sometimes develop profusely. On young seedlings the spots are generally below or at the point of attachment of the cotyledons due to the spores being washed down from the diseased cotyledons. On older plants, the spots are more scattered over the different parts of the stems. The spots appear quite suddenly on the stems and differ but little from those on the pods (Plate IV). However they are as a rule elongated in the direction of the main axis of the stem. Sometimes, also, there are dark streaks extending up and down from the spots. These streaks are quite distinct near the spots but gradually fade out in the healthy tissue of the host. The spots are black and slightly sunken, and, as on the pods, become covered with the pink, slimy exudate of spores. By coalescence, the spots may form large lesions three or four inches in length. As these large lesions grow older, they dry out and the tissue cracks (Plate VI). Often on young plants, the disease becomes so bad that the stem completely rots and we have a "damping off" effect (Plate IV). On older parts of the stem, when the tissue becomes hard, the spots rarely form; and when they do, they remain small.

THE SPOTS ON THE SEED.

On the seed, the disease appears also in yellowish, brownish, or blackish spots. These are located directly under the spots on the pods and are formed by the fungus growing down through the pod tissue and into the seed. Generally the spots are rusty brown or black, but if the disease has just reached to the seed, merely a yellow spot may be formed. The spots are various in size from a mere speck up to one including the whole side of the bean. As a rule, they are round, but may vary into irregular shapes. These are also, as a rule, surrounded by a reddish zone. The spots may or may not be sunken and may or may not contain acervuli and spores. This depends entirely upon how badly affected the seed may be.

THE SPOTS ON THE COTYLEDONS.

The spots on the cotyledons are the same as those on the seed. When the seed absorbs water in germination, the fungus also begins to grow. While on the seed, we have the fungus in a dormant condition; in the spots on the cotyledons, we have the fungus in a growing condition in the same spots. The spots enlarge, become more shrunken, and develop spores in abundance. The spots are quite similar in appearance to those on the pods.

MICROSCOPIC STRUCTURE OF THE SPOTS ON THE PODS.

When the spots are first noticed on the pods, they are small, yellowish, or slightly brownish in color, and round or somewhat oval in shape. At first, these spots are not sunken, but become slightly so in twenty-four hours after being first visible. The spots are always more or less localized. Even in sections of young spots, it is generally an easy mattery to see the boundary between the diseased and healthy tissue.

The structure of the healthy bean pod is as follows: On the surface there is the epidermal layer of cells of the ordinary rectangular shape, thin walled except on the outside where there is a rather thick, and very much corrugated cuticle. Under the epidermal layer, there is a tissue made up of thin walled polygonal cells from ten to twenty cells in thickness. Below this there are a few scattering, poorly developed fibro-vascular bundles and under these a rather dense layer of very small cells placed very close together. This last layer is only three to five cells in thickness. Under this again is a thick layer of large polygonal thin walled cells.

A section now of a young anthracnose spot shows the cells unchanged in shape, but the upper layer of large polygonal cells contains an abundance of mycelial threads of the fungus and very little of the original protoplasmic contents of the cells. The mycelium stains deeply and appears very prominent when stained with Iron Alum Haematoxylin. A small region on the boundary between healthy and diseased tissue is made up of cells which have also lost most of their protoplasmic contents but which as yet contain very little fungus mycelium.

When the spot is about twenty-four to thirty-six hours old, the outer cells begin to collapse and as a result the spot becomes shrunken. Figure 1, in Plate XII, shows cells that are just beginning to shrink. The cells in the lower part of the figure are still polygonal and normal in shape but those near the surface are becoming flattened. During the development of the spot, the mycelium continues to spread in all directions. However when it reaches the thin layer of small cells its inward development seems to be slightly checked. In some cases, it does not seem to be able to pass this layer of cells, but in most cases, if the conditions for development are good, the mycelium grows through these cells and into the large ones beneath.

The cells in the tissue just underneath the epidermis dry out very rapidly, and in spots two to five days old, the cell walls in many cases are lying side by side (Plate VII, fig. 2). At this stage the boundary line between the living and dead cells is very distinct, as is shown in the figure.

The action of the fungus on the deeper layer of large polygonal cells is somewhat different from that on those just underneath the epidermis. The outer cells, as has been said, dry and shrink, but the inner ones are more or less protected from this shrinking. But the fungus seems to disintegrate these almost entirely. A section at this time will generally show a large empty cavity (Plate VII, fig. 2) between the outer layers and the healthy tissue near the bottom of the spot. The accompanying photomicrograph is very typical of old anthracnose spots on the pods, it showing the sharp boundary between healthy and diseased tissue; the dead, deeply staining cells, packed full with fungus mycelium and apparently in contact with healthy ones; the shrunken cells of the outer layer of the pod; and the disintegrated cells of the inner layer.

The development of the acervuli in these spots will be considered later under the development of the fungus.

MISCROSCOPIC STRUCTURE OF THE SPOTS ON THE SEEDS.

The microscopic study of the diseased seed presented some interesting information. On account of the thicknness of the cell walls, the density of the cell contents, etc., the cutting and staining of sections is rather unsatisfactory. But some fairly good sections were obtained. These showed the spots to be localized similar to those on the pods. As the diseased portion takes the stain very deeply, there was a sharp contrast between this portion and the healthy tissue. The diseased cells are more or less shrunken and poorly developed.

Acervuli are often present on the surface of the spots and also between the cotyledons. Also some of the sections of diseased seed showed very interesting fruiting pustules buried in the tissue of the bean. These (Plate XIII, Figs. 2 and 4) were closed pycnidial like bodies buried some distance beneath the surface of the bean. It appeared as if the fungus had caused a spreading apart of some of the layers of cells and then formed a conidiophore layer around the margin of this cavity. These pycnidia were packed full of spores which seemed to be in a perfectly healthy state. Two of these pycnidial like cavities are shown in the photomicrograph in Plate XII, Fig. 2. These are the two more or less clear places lying in a line about an inch from the upper edge of the figure. Figure 4 shows one of these under greater magnification. While this is not very clear, it shows the parallel conidiophores on all sides of the cavity and the abundance of spores in the center. These pycnidial-like fruiting bodies vary in size, as I have seen them, from 80—130x80—520 microns.

NORMAL LIFE HISTORY OF THE FUNGUS.

The bean anthracnose, while it follows in a general way the life history of other anthracnoses, differs in some of the details. The different steps in the life history of the fungus are more or less familiar to plant pathologists, and it will not be necessary to give a very extended discussion at this time, and so I will only briefly trace the normal development of the fungus through its different stages. The spores, which may be used for a starting point, are developed in all of the spots previously described. These are imbedded in a gelatinous matrix and are only disseminated by being washed off by rain or dew, or by being rubbed off. As long as the spores are imbedded in this mucilaginous substance they will not germinate, but when they are washed out of this and are placed in a moist place they quickly germinate. If the spore comes to rest on some part of the bean plant, as for instance a pod, and if the pod is moist, as it generally is at times when the spore would be placed there, it quickly sends out a germ tube at a point near the end of the spore. This tube only grows for a short distance when there is formed at its end, a dark brown cell known as a secondary spore or appressorium. This latter spore soon germinates and forms a small tube which bores its way through the epidermal cells of the host plant. If a surface section of a pod is examined some 12 to 24 hours after it is sprayed with a suspension of spores in water, a considerable number of the appressoria will be seen. I have tried to get cross sections, both by free hand and with the microtome, that would show the entrance of the germ tube, but from the lack of a good differential stain, I have not been able to get one to show satisfactory. Some of them showed indistinctly, but not clear enough to be photographed or drawn. After the fungus has entered the host tissue, it bores its way from cell to cell, passing directly through the cell walls. The cells become filled with mycelium and after the normal period of incubation they die and collapse. The fungus continues to grow, spreading rather rapidly at first, but later for some reason, the growth is checked and the fungus remains localized. The mycelium does not extend out further than the host tissue is discolored.

After the host tissue is killed, the fruiting pustules of the fungus develop. In the development of the acervulus, there is at first a collection of a few large mycelial threads in the epidermal and sub-epidermal layers of cells (Plate XII, fig. 1). These few scattering threads quickly give rise to a number of conidiophores lying side by side and nearly perpendicular to the surface of the pod (Fig. 2). Generally in descriptions of the development of the acervulus, authors state that the formation of the conidiophores is preceded by the formation of a stroma, Beach (2) says: ''The mycelium * * * just beneath the epidermis * * * forms a dense dark colored stroma which precedes the production of spores.'' A glance at Fig. 2 will show that no stroma precedes the development of the conidiophores. These are only preceded by a few scattered threads as shown in figure 1. These conidiophores, while few at first rapidly increase in number (Fig. 3, 4, and 5). These develop in the two or three layers of cells underneath the cuticle. They also increase in length, raising the cuticle of the host plant and finally rupturing it, though the rupturing seldom occurs before a few spores begin to form. Often there is a later development of a stroma of pseudo-parenchymatous cells (Fig. 6).

Spores very soon form after the conidiophores develop. A constriction is formed a short distance back from the apex of the conidiophore and the apical portion, which is now the spore, is cut off. Spore after spore is cut off from each conidiophore and in a short time there is a mass of spores at the surface of the acervulus. Although the cuticle is ruptured soon after the spores begin to develop, it still holds the spores more or less confined, and they are only forced out of the small opening formed, (Plate XIII, fig. 1). Later, however, the cuticle is thrown entirely aside, and the mass of spores takes on the appearance as shown in figure 4. The spores are held together at the surface of the acervulus by the mucilaginous substance secreted by the fungus.

Spores are formed in great numbers and very rapidly. I estimated the number of spores on the pod farthest to the right in Plate I. This pod is quite severely effected, but no worse than many pods in the field. On bringing the pod in, I washed off all the spores in a definite amount of water. By diluting this suspension of spores and making poured plates from a very small per cent of it, I estimated the number of spores on the pod as between 110 and 115 million. The pod was then placed in a moist chamber for 24 hours and spores allowed to develop again. At the end of this period, there were again between 45 and 50 million spores on the pod. It is safe to say that some pods may develop from one-half to one billion spores during their growth.

After the spores begin to form, quite frequently there develop a few scattering setae in the acervulus. However these are not always present, and it was some years after the bean anthracnose was discovered before these were seen (28). These are as a rule slightly more abundant than in the related form on apple, but less abundant than in the form on cotton.

If the spot on the pod is directly over a developing seed within, and if the infection has been early and conditions are suitable for a good development of the fungus, often the mycelium penetrates entirely through the pod tissue and through the seed coats into the seed itself. The tissue of the seed is killed in the same manner as that of the pod. The size of the spot formed on the seed depends upon how near mature the seed was when first affected, and upon temperature conditions. If the seed becomes infected when it is young, the spot may cover half of the seed and may grow to the center of the seed or even beyond. If the seed becomes infected later, the spot remains smaller and shallower. A common condition is where the discoloration is in the seed coats alone, the cotyledons below, when exposed, appearing normal. Large spots on the seeds generally contain spores in abundance on the surface. Spores may also develop abundantly between the cotyledons and also in buried pycnidial structures in the tissue itself as described above.

In cases where the disease does not pass entirely through the pod tissue, there is often a lack of development of the tissue of the seed directly under the spot. An examination of a large number of seed from directly under anthracnose spots, seed that showed no infection, not even any discoloration, showed a large per cent to have depressions at the point nearest to the spot on the pod. It would appear from this that the developing seed draws nourishment from the pod from all sides, and if some of this pod tissue is used up by the fungus, that portion of the seed nearest to the diseased portion of the pod naturally fails to develop. These depressions in the seed were sometimes a millimeter in depth though generally shallower.

The spots on the leaves and stems develop in a smilar manner to those on the pods.

Of course any portion of the plant may be infected from any other diseased portion, but the usual course of the infection is as follows: The disease, being present in the seed, continues to develop on the cotyledons. By the time the cotyledons are above the ground, the spores are generally abundant in the spots. These are washed off with the rain and dew and pass down on the stems and ground. Finding lodgment on the stems, they quickly cause the spots there. Spots on the stems above the cotyledons are rare on young plants. The leaves above, then become infected by being blown against the diseased cotyledons or stems, or the ground, or by rain splashing up the spores from the ground on to them. Spots form on the leaves and the spores are washed down from these on to the higher parts of the stems and the pods.

If the different plants in the field are in contact, the spread of the disease may be rapid, but if they are separated, the spread of the trouble is very materially checked. While the disease may be spread by insects in some cases, there is no evidence to prove it. I have seen large patches of beans less than 100 yards apart, where one patch would be badly affected and the other without any anthracnose whatever. The disease is without doubt spread most frequently through different parts of the field by the carelessness of the growers in walking through or working the fields while the plants are wet with rain or dew. The disease may also be spread by a severe storm which whips the plants a great deal.

The ascogenous or perfect stage of the fungus has never been observed, as far as I know, on plants in the field. Shear and Wood (29), however, have reported it in pure cultures on artificial media. I have tried many times to get a strain that would produce the perfect stage but as yet have been unsuccessful. The perfect stage of the bean anthracnose needs to be studied very carefully. The other characters of the fungus are so different from the anthracnoses from other hosts, that it would not be surprising if the characters of the perfect stage would also be slightly different.

PERIOD OF INCUBATION.

Frank (10) claims to have secured brown spots and mycelium 24 hourse after infection with the fungus. Halsted (17) states that he procured infection after 36 hours. But from very carefully conducted experiments, I am unable to agree with either statement. The lowest period of incubation which I have been able to obtain was four and one-half days. Longer periods than this are generally the rule, especially if the weather and temperature conditions are not quite favorable. In determining the period of incubation, I have used plants in both field and greenhouse. All the inoculations were made by spraying on the plants a suspension of spores in water by means of an atomizer. No experiments were tried with needle punctures as the disease does not seem to gain entrance through wounds. Various parts of the plants were inoculated, but the period of incubation seemed to be the same on pods, stems, and leaves. Two different cultures were used in these experiments, both obtained from germinating seed, one isolated in November, 1908, and the other about February 1, 1909. These two cultures were identical and when used at the same time gave the same amount of infection and the same period of incubation. The following tables show the results of the experiments tried to determine the period of incubation. The dates given are the ones in which the first spots were able to be seen. The plants were examined about twice or three times a day after they were inoculated. In all cases, unless otherwise stated, on the first or second day following the date given in the tables, the pods and all young parts of the plants were covered with spots. The pods in Plate I were taken from some of the infection experiments.

Table 1 shows the results of inoculations in the greenhouse. I have included the dates, the number of plants used in each case, the parts inoculated, and the treatment of the plants. By treatment, I mean the length of time that the plants were covered with bell jars. In all cases, except one, the inside of the bell jar was covered with wet paper. Two sets of plants were inoculated without being covered with jars. Of all of the inoculations conducted, these were the only ones in which I failed to get an abundant infection.

TABLE NO. 1.

GREENHOUSE INFECTIONS.

No. of Plants.	Date of Inoculation.	Period Covered.	Parts Inoculated.	Date First Spots.	Period of Incubation.	REMARKS.
4	Mar. 22, P. M.	40 hrs.	Levs. and Stems.	Mar. 27, P. M.	5 days.	
6	Mar. 26, P. M.	40 hrs.	Lvs., Sts. and Pods.	Mar. 31, P. M.	5 days.	
2	Mar. 24.	0	Lvs., Sts.	Apr. 3.	9 days.	Slight Inf.
2	Mar. 24.	16 hrs.	Lvs., Sts.	Apr. 1.	7 days.	
2	Mar. 24.	24 hrs.	Lvs., Sts.	Mar. 29.	5 days	
2	Mar. 24.	40 hrs.	Lvs., Sts.	Mar. 29.	5 days.	
2	Mar. 24.	60 hrs.	Lvs. Sts.	Mar. 29.	5 days.	
2	Apr. 5. P. M.	40 hrs.*	Lvs. Sts.	Apr. 10, P. M.	5 days.	
4	Apr. 5, P. M.	40 hrs.	Lvs. Sts.	Apr. 10, A. M.	4½ days.	
2	Apr. 5, P. M.	0	Lvs. Sts.	....	....	No. Inf.

*The bell jar covering these plants had no lining of wet paper.

The lowest period of incubation obtained in these experiments was four and one-half days, and the conditions in most of them were the best possible for the development of the fungus. Where the plants were not protected from drying, longer periods of incubation were obtained. The greenhouse was very dry and those plants that were not covered at all gave very slight infection, one set not becoming infected at all and the other not until the end of nine days. Sixteen hours was also not quite sufficient for the fungus to get thoroughly established before the plants became dry. But plants covered for 24 hours were as badly infected as those covered for 60 hours. To get the best infection, it would seem, that we should have about 24 hours of rainy weather. In Louisiana, where we have heavy dews which stay on the plants until nearly eleven o'clock, we have conditions approaching the optimum for the fungus.

The field inoculations were mostly carried on during a rainy spell. I wanted to try some during a dry spell to test the effect of the dews alone, but I did not have an isolated patch in good shape for inoculation during the dry spell we had during the last of April. In each experiment ten hills of beans were used, there being on an average of three plants to the hill. Each plant contained from fifteen to twenty-five pods. Altogether there were nearly 400 plants used in the field inoculations. In all of the infection experiments, both in the greenhouse and in the field, check plants were used, but in no case did spots develop on these. In Table No. 2, I have given the date of inoculation, date of first spots, weather conditions, and age of the culture used for inoculation.

TABLE NO. 2.

FIELD INFECTIONS.

Date of Inoculation.	Age of Culture.	Weather 24 hours previous.	Weather 24 hours following.	Date of first spots.	Period of Incubation.
May 15, 12 Noon	15 days.	Warm, dry.	Warm, dry.	May 21, Morning.	5½ days.
May 16, 9:30 A. M.	16 days.	Warm, dry.	Shower, cloudy.	May 21, Morning.	5 days.
May 17, 9 A. M.	17 days.	Shower, cloudy.	Warm, showers	May 22, 6 P. M.	5½ days.
May 17, 5 P. M.	17 days.	Showers.	Rain, warm.	May 23, 10 A. M.	5½ days.
May 18, 9 A. M.	18 days.	Rain.	Warm, shower.	May 24, 9 A. M.	6 days.
May 18, 5:30 P. M.	4 days.	Rain.	Rain.	May 23, P. M.	5 days.
May 19 9 A. M.	5 days.	Rain.	Warm, sunshiny.	May 24, 6 P. M.	5½ days.
May 19, 6 P. M.	5 days.	Warm, sunshiny	Heavy dew. cool.	May 25, 9 A. M.	5½ days.
May 20. 9 A. M.	4 days.	Cool, heavy dew.	Warm, shower.	May 25, 6 P. M.	5½ days.
May 20, 6 P. M.	4 days.	Warm.	Shower.	May 25, 6 P. M.	5 days.
Map 21, 12 Noon	4 days.	Shower	Sunshiny.	May 26, 8:30 A. M.	4 5-6 days
May 21, 6 P. M.	21 days.	Warm.	No rain.	May 26, 6 P. M.	5 days.

The period of incubation in the field tests runs from slightly under five days to six days. The weather conditions were not variable enough to give any variation in the period of incubation, or else the heavy dews were sufficient to cause abundant infection in spite of any lack of rain. The weather during the inoculation experiments was quite warm during the days, but with cool nights.

It is hard to understand how Frank and Halsted obtained the results they did, unless they used plants which were already previously infected. It would be impossible to conduct such experiments in a field where there was any disease present, as the results would not be reliable. The above described experiments were conducted upon plants grown from clean seed, and at no time did any plants become infected other than those inoculated.

GROWTH IN CULTURE MEDIA.

Cultures have been made of this fungus at various times from different localities and from different parts of the host plant. The various points which can be studied by the use of cultural technique have been considered; as the germination of spores under various conditions, cultural characters, spore and appressoria formation, variability of cultures, etc. Various culture media have been used during the course of the study including potato, bean, and rice agars; bean pods; alfalfa and Egyptian clover stems; cornmeal; Prazmouski's nutrient solution, etc. The culture work has been conducted in the usual manner.

Germination of Spores.

The characters of spore germination vary with the culture media used, the age of the spores, and the number of spores in the liquid in which they are germinating. A spore in pure water germinates after a few hours by sending out a small germ tube which only grows for a short distance when there is formed at its end an appressorium, the contents of the spore and germ tube passing gradually into the appressorium. Sometimes a second germ tube may be formed, but this is not the rule. If the water used contains a small amount of food material, as ordinary tap water generally does, the germ tube is longer. In these cases, where the amount of food material is relatively small, the germ tube is generally narrow. Often, also, under these conditions, when there are a number of spores in the medium, the germ tubes will anastamose (Fig. 12, Plate XIV). The per cent of germination in water is often low, and rarely do all of the spores germinate at once. A few will germinate in a few hours while some will not germinate for a day or more. Where the surrounding medium is rich in organic food material, the germination is generally simultaneous.

In ordinary nutrient media, if the spores are scattering, they germinate by sending out germ tubes slightly smaller than the spores themselves. These tubes are sent out, as a rule, from near the end of the spores, and at a slight angle to their main axis. The first germ tube is often followed by one or two others from different parts of the spore. These absorb the food from the culture medium and soon there is developed a much branched and septate mycelium. The walls of the mycelial threads at this time are thin and hyaline, and the protoplasmic contents somewhat granular. The identity of the spore soon becomes lost in the network of mycelium that is developed. The spores swell but very slightly, if at all, in germination under these conditions.

However, if the spores are very abundant and close together in the culture medium, a different sort of germination results (Plate XIV, fig. 5 and 6). There is at first a swelling of the spore, with generally the formation of a septum through the center. Further swelling of the spore after the formation of the septum, causes the spore to become constricted at that point (Fig. 6). The spore sometimes swells to a size two to three times that of the normal one. Often from these large swollen spores, germ tubes of various sizes are sent out. These, however, seldom grow to any great length. This sort of germination is very similar, if not identical, with that described by Atkinson (1). I made a number of plates with varying numbers of spores in them, the number of spores being estimated in each case. The spores were then allowed to germinate with the following results:

150 spores to cubic mm. of medium. Spores very much swollen and septate with but few germ tubes.

75 spores to cubic mm. of medium. Spores much swollen and septate, with about 25 to 50 per cent with germ tubes.

30 spores to cubic mm. of medium. Spores more or less swollen and septate, with about 50 to 90 per cent with germ tubes.

16 spores to cubic mm. of medium. Spores but slightly swollen with nearly 100 per cent with germ tubes.

12 spores to cubic mm. of medium. Very similar to the preceding.

6 spores to cubic mm. of medium. Practically no swelling with germination normal and practically 100 per cent.

From this we see, that when the spores are crowded, that is, when there are more than 12 or 15 spores to the cubic millimeter of medium, the spores become swollen, germinate slowly and but poorly. When the number is less than this, they germinate with but little, if any, swelling. Whether the spores give off an enzym in germination which prohibits growth is questionable, but it seems reasonable.

The spores that swell and germinate in this way, often act in a peculiar manner later. The germ tubes, if they do develop, only grow for short distances. Some of them stop growth at this point with no further change. Often, however, spores are again formed on these short germ tubes (Plate XIV, fig. 7). Often, also, spores may develop directly from the swollen spore without the previous development of a germ tube (fig. 7). The spores that develop in these ways are perfectly normal, appearing identical with those that develop in acervuli on bean pods.

Another variation appeared in the germination of old dried spores. Some experiments, which will be discussed later, were tried to see how long dried spores were viable. These spores, just before they lost their viability, germinated slowly in nutrient media. Although they were not crowded, they swelled somewhat and then sent out very large germ tubes, as large as the swollen spores themselves (fig. 8). These grew slowly at first, but later took on the ordinary method of growth.

DETERIORATION OF SPORES.

A spore when first formed, is composed of an apparently homogenous, granular protoplasm, with the exception of the small, round, clear nucleus near the center. In cultures, these spores form in large pink masses, retaining this color for from one to three weeks or even more, and then gradually fading out to a cream color. If examined microscopically during this change of color, a change in the contents of the spores themselves will be observed. The protoplasmic contents, which at first completely fill the spore, gradually shrink and vacuoles of various sizes are formed (Plate XIV, fig. 2). This shrinking of the protoplasmic contents continues, the vacuoles growing larger until there is little left beyond a rim of protoplasm lining the wall of the spore. As deterioration continues, the protoplasm seems to go to pieces, and becomes collected in balls and masses throughout the interior of the spore (fig. 3). In some spores, the protoplasmic contents seem to entirely disappear. Germination tests were made of the spores in these different conditions. Spores that are merely vacuolate are still capable of germination. They absorb water from the nutrient medium causing the vacoles to entirely disappear, and as a result becoming perfectly normal in appearance. They then germinate in the usual manner. However, the spores in which the protoplasm has broken away from the edge and collected in masses, are not capable of assuming their ordinary appearance or of germination.

FORMATION OF APPRESSORA.

The large dark cells formed by various forms of anthracnoses and called appressoria or secondary spores (Plate XIV, fig. 10 and 11) are developed by the bean anthracnose at various times. As has been mentioned, they form on the bean pods previous to infection and also in germination in pure water. They also form occassionally in pure cultures. Here they do not necesarily develop in contact with the glass of the petri dish or tube. In crowded cultures, they often form in the agar entirely distinct from the glass or any solid substance in the media. In appressoria which I have observed from the bean anthracnose, the clear spot near the center, the so-called "germ pore" has often been lacking.

CULTURAL CHARACTERS.

The cultural characters of the bean anthracnose are quite distinct from all other members of this group which I have studied. The only other one that I have found that has characters approaching them is one which I found on Ludwigia alternifolia at Baton Rouge, and this could hardly be said to be similar. The two most distinguishing characters of the bean anthracnose are the more or less localized growth and the deep black color which appears in cultures a few days old. If a germinating spore is placed in the center of a petri dish containing sterile agar, the resulting growth seldom extends out more than a centimeter from the initial point. The growth is at first white but soon takes on a jet black color. The growth is generally nearly strict, though occassionally there may be a little aerial growth. The spores form on this black substratum as a pink slimy covering or in pink pustules. In tubes containing sterile bean pods or stems of various plants as alfalfa or cowpeas, the mycelium may finally cover the whole exposed surface though the growth is generally comparatively slow. On all culture media, on which I have grown this form, the deep black color appeared.

Of all the cultures I have made of the bean anthracnose from various localities and from various parts of the bean plant, I have seen no differences in the culture characters. Furthermore, cultures which have been kept for a year or more have shown, as far as I could see, no variation. Many other anthracnoses are extremely variable as has been shown in a previous paper (6). Perhaps the anthracnoses which have shown the greatest variability are those which seem to have lost the power to produce the ascogenous stage, while the most constant ones are those which readily produce this stage. Reasoning from this, I have often thought that the bean anthracnose probably has the ascogenous stage developing at times.

MYCELIAL CHARACTERS IN PURE CULTURE.

In a young culture of the bean anthracnose, the mycelial threads are hyaline, small, and more or less of the same size. But as the culture grows older, these small threads are displaced by much larger filaments. These filaments are somewhat irregular and more or less broken up. The individual cells are more or less rounded and coarsely granular (Plate XIV fig. 14). These remind one very much of some of Viala and Pacotett's (35) figures and descriptions in their articles in which they attempted to show that the anthracnoses had yeast forms in their life cycle. These large filaments gradually darken in color and become thick walled (Plate XIV, fig. 13). These black threads compose the stroma or crust which is seen on all old cultures. While this may not be a true stroma, it has many of the characteristics of one. This black growth is often pseudo-parenchymatous in character.

PERIOD OF VIABILITY OF SPORES.

The spores of the anthracnoses are supposed to lose their viability in a short time, especially after they have become freed from the mucilaginous substance in which they are imbedded. Experiments were undertaken to test this with the bean anthracnose. Two lines of investigations were undertaken: 1st, to see how long spores that developed on the bean seed would remain viable; and, 2nd, to see the effect of drying on the viability under various conditions.

The experiments from seeds and pods were as follows:

In March, 1908, I obtained diseased seed in the market, and placed some of the spores in drops of sterile water and left them to germinate. No spores germinated.

In March, 1908, I placed some spores from pods that were picked in May, 1907, in drops of sterile water and left to germinate. No spores germinated. These two tests were hardly fair ones, as fresh spores do not germinate very well in pure water. Furthermore, only a relatively small number of spores were under observation.

In February, 1909, I again obtained diseased seed on the market, without doubt seed of the 1908 crop. Cultures in potato agar were made from the spores on the spots on three beans. From one bean, no spores were seen to germinate, but from the other two, a few scattering spores germinated and grew into the typical colonies. Cultures from these gave good infection when sprayed again on young bean plants.

Dilution cultures were made at the same time from spores that had developed between the cotyledons in the seed. These gave a very high per cent of germination, nearly as high as fresh spores. As planting time for beans in Louisiana is in March, it is evident that some of the spores on the diseased seed are still capable of germination at that time, and it is possible that some of the infection on the young plants come from these.

These spores are rubbed off the diseased seed to the healthy ones, and when the beans are planted, germinate and infect the young plants. It is barely possible that this is one of the reasons why the picking out of diseased seed has been a failure from the standpoint of the control of the disease. Perhaps the picking out of the diseased seed, combined with some seed treatment to kill any spores on the surface, would give better results. It has been taken for granted that the seedling infection comes entirely from diseased seed, but from the germination tests just given, a second method, the infection from spores must be taken into consideration.

Tests were made in the spring of 1909 to see how long spores would remain viable when they were allowed to dry down in their own mucilaginous covering, and also how long when they were freed from this. Hasselbring (20) in working on the bitter rot of apples, found that spores washed free from the mucilaginous matrix and allowed to dry, would not germinate in water a day or so later; while those that were left imbedded in this substance retained their power to germinate for some time. As bean anthracnose spores do not germinate extra well in water, for the following tests nutrient media was used. Spores in all cases were obtained from pure cultures.

In order to dry the spores thoroughly and also to keep them away from any contamination, they were placed on sterile cover slips and placed in petri dishes that had been previously sterilized. Spores were placed on these cover slips in three different methods as follows:

Lot No. 1. A mass of spores was placed directly on the cover slip, and these were allowed to dry down in their own mucilaginous matrix.

Lot No. 2. Spores were placed in drops of sterile water on the cover slip and the water allowed to evaporate. This at least partially freed the spores from the mucilaginous covering.

Lot No. 3. Spores were placed in drops of sterile potato bouillion on the cover slips and allowed to dry.

A number of cover slip preparations were made in each lot. These were left in the petri dishes in the laboratory for different periods. To test for germination, a cover slip was dropped in a tube of melted agar, the spores rubbed off in the medium, and a poured plate made. In the following table the results of the germination after different periods of drying is given:

TABLE NO. 3.

EFFECTS OF DRYING ON GERMINATION OF SPORES.

Lot. No.	Time Dried	Number of Plates	RESULTS
1....	2 days	1	Some germination. Better than two following.
2....	2 days	1	Some germination. Better than next following.
3....	2 days	1	Some germination.
1....	6 days	1	A few spores germinated.
2....	6 days	1	A few spores germinated.
3....	6 days	1	A few spores germinated.
1....	17 days	3	2 plates, no colonies; 1 plate, about 100 colonies.
2....	17 days	3	No germination.
3....	17 days	3	2 plates, no colonies; 1 plate, 1 colony.
1....	30 days	5	No germination.
2....	30 days	5	No germination.
3....	30 days	4	No germination.

While the per cent of germination decreased in all quite rapidly, very little difference, if any could be observed in the different lots. In seventeen days only a very small per cent of any of the spores were viable and after thirty days there were none.

In order to free the spores entirely from the surrounding mucilaginous covering, a second experiment was conducted. Spores were placed on sterile cover slips in sterile petri dishes as in the previous experiment but the preliminary treatment of the spores was somewhat different. They were treated as follows:

Lot No. 1. Spores were placed directly on the cover slips and allowed to dry down in their mucilaginous covering.

Lot No. 2. The spores were first placed in sterile water in a previously plugged and sterilized sedimentation tube. They were then centrifuged for about three minutes. By this method, the spores were freed from the mucilaginous covering and were also thrown down in mass in the bottom of the tube. The water was then poured off and the spores from the bottom were placed on the cover slips and allowed to dry.

Lot No. 3. The spores were centrifuged as in Lot No. 2, and were then placed in drops of potato bouillon on the cover slips and allowed to dry.

The spores were dried on February 15, 1909. Cultures were made the same day from one of the slips in Lot No. 2 to see if the contrifuging alone had had any effect on their germinating power, but these spores germinated practically 100 per cent. Cultures were made from these different lots from time to time as in the previous experiment, the results being given in the following table:

TABLE NO. 4.

EFFECT OF DRYING ON GERMINATION OF SPORES.

Lot. No.	Time Dried	Number of Plates	RESULTS
2....	0 days	1	100 per cent germination.
1....	1 day	1	Good germination, though not 100 per cent.
2....	1 day	1	Good germination, though not 100 per cent.
3....	1 day	1	Good germination, though not 100 per cent.
1....	3 days	1	Good germination.
2....	3 days	1	Good germination.
3....	3 days	1	Good germination.
1....	5 days	1	Good germination.
2....	5 days	1	Good germination.
3....	5 days	1	Good germination.
1....	7 days	1	Good germination.
2....	7 days	1	Good germination.
3....	7 days	1	Good germination.
1....	9 days	1	Good germination.
2....	9 days	1	Slight germination.
3....	9 days	1	Slight germination.
1....	11 days	1	No germination.
2....	11 days	2	Fair germination.
3....	11 days	2	Slight germination.
1....	13 days	2	Good germination. Hundreds of colonies.
2....	13 days	2	1 plate, no colonies; 1 plate, 14 colonies.
3....	13 days	2	Good germination.
1....	15 days	1	No germination.
2....	15 days	2	1 plate, 1 colony; 1 plate, hundreds of colonies.
3....	15 days	1	About 100 colonies in plate.
1....	17 days	1	Slight germination.
2....	17 days	1	30-40 colonies in plate.
3....	17 days	1	No germination.
1....	19 days	2	1 plate, no colonies; 1 plate, 18 colonies.
2....	19 days	1	2 colonies in plate.
3....	19 days	2	More than 100 colonies in each plate.
1....	22 days	2	1 plate, no colonies; 1 plate, 3 colonies.
2....	22 days	2	No germination.
3....	22 days	2	1 plate, no colonies; 1 plate, 200-300 colonies.

On the last day, all the cover slips which had been prepared were used, and the experiment was necessarily discontinued. While it is probable that there would have been some germination for a few days longer, most of the spores had lost their power to germinate at the end of twenty-two days. While some of the results are somewhat erratic, they show conclusively that it makes little difference to the spores whether they are imbedded in the mucilaginous substance or are freed from it from the standpoint of resistance to drying. From Hasselbring's results, it would have been expected that the centrifuged spores would have lost their power of germination in a day or so, but this was not the case. Perhaps, also, if Hasselbring had used nutrient media for the germination of the bitter rot spores, he would have obtained different results.

RELATION OF FUNGUS TO ACID AND ALKALI.

In a previous paper (6), attention has been called to the fact that the bean anthracnose is one member of this group that will not grow in a medium containing any great amount of acid. Most anthracnoses can be readily cultured by acidifying the medium in order to eliminate the bacteria, but the bean anthracnose is one of the forms that can not be cultured in this way. A medium that contains enough acid to eliminate the common forms of bacteria will also prevent the growth of the anthracnose. To test the amount of acidity this fungus would tolerate, bean agar was made, titrated, and brought up to different per cents of alkalinity and acidity. The per cents given are those of Fuller's scale. In the titrations, each time a sufficient amount of sodium hydrate was used to give the solution a good rose color. In the following table, I have compared the growth on the media with different acidity, with that of the cotton anthracnose, Glomerella gossypii. The results with the anthracnoses from the fig and pepper were very similar to those of the cotton form:

TABLE No. 5.

EFFECT OF ACIDITY AND ALKALINITY ON GROWTH.

Fungus.	Degree of Acidity or Alkalinity.							
	—16	—6	+5	+15	+20	+25	+38	+43
C. lindemuthianum	Fair	Good	Excellent	Good	Slight	None	None	None
C. gossypii	Good	Good	Excellent	Excellent	Excellent	Fair	Slight	None

The table does not show the amount of alkalinity the two fungi will tolerate, as they both grew fairly well on the medium with the highest percent of alkalinity, —16. But from the standpoint of acidity, the table shows a striking difference between the two fungi. The maximum acidity of the bean anthracnose is about +20, while the maximum for the cotton anthracnose is about +38. The optimum in both cases seemed to be about +5, though there was not a great deal of difference between —6 and +15.

RELATION OF FUNGUS TO TEMPERATURE.

The temperature factor is a very important one in regard to the bean anthracnose, especially in regard to its control. There are many instances on record where the spread and development of this disease has been suddenly checked, presumably from weather conditions. As a rule, these are said to be due to dry weather. But, after observations on the trouble for the past two years in a climate where the effects of the hot weather could be studied, it seems that the hot weather factor should be considered. While wet weather is essential for the spread of the disease, it is not essential for the development of the spots after the fungus has once gained entrance in the tissues of the bean plant.

In the northern states the temperature factor is not so important as in the south, on account of the lower mean temperature and the cooler nights. For only short spells during the growing season in the north is the weather so warm that it would be detrimental to fungi that can not tolerate a high temperature. It is probably due to this that the temperature factor has been overlooked in the study of the disease. But little research work has been done on it in the south, and so the relation to temperature has not been observed.

The relation to temperature has been studied, under this investigation, both in the laboratory and in the field. On account of the lack of sufficient laboratory facilities, it has been impossible to work out the minimum, optimum, and maximum temperatures for growth, points which should be determined. But the data that has been obtained has shown conclusively that the bean anthracnose cannot tolerate a high temperature. The lower temperatures have always given a better growth and a better production of spores.

Perhaps the most conclusive evidence in this regard from the laboratory studies, was obtained in the difficulty in keeping the fungus alive in cultures through the summer. In the season of 1908, cultures of the fungus died out entirely, though the same precautions, with frequent transfers, were used, as with other fungi. I was not perfectly sure at the time that this might not have been due to carelessness in some way, so I tried again in 1909 to keep the fungus through the summer. The season was started with two different cultures. During the spring they grew very rapidly, producing an abundance of spores on bean pods or clover stems three days after the transfer. But when the hot weather came on in June, considerable difficulty was experienced. All during the summer frequent transfers were made, from one to three weeks apart. One culture died out in spite of anything that could be done. The culture did not become contaminated, as transfers gave absolutely no growth. However, with the other culture I was more fortunate. I was able to keep this alive, though at one time I thought that it was dead. The growth was extremely slow during the hot weather. For instance, transfers were made June 10. For several days there was no perceptible growth, and after fifty days—on July 30—the growth in these tubes (alfalfa stems) was less than one inch long. Transfers made on June 30, on sterilized bean pods, gave a very weak growth; twenty-five days later, the colonies on the pods being only six to eight millimeters in diameter. Many of the transfers that I made did die out, but from some I was able to keep up a weak growth. It was not until the cooler weather of September and October came on, that I was able again to get a growth that was rapid and normal. Transfers made at this time gave a good, rapid growth, with an abundance of spores. The fungus had not changed during this period, as far as I could see. The growth looked identical with that of the previous spring, and inoculation experiments gave infection on young bean plants.

In the field, observations were made and experiments were conducted to test the effect of the temperature. While, under field conditions, there are other factors entering, as the rainfall and humidity, effect of micro-organisms of the soil, etc., the evidence seems conclusive that the temperature is a very important factor with this disease. The trouble was very bad during most of the month of May, but from the last two or three days in May on through the rest of the summer, there was no development of the trouble. The following table gives the daily maximum, minimum, and mean temperatures at Baton Rouge for a period during this time.

TABLE 6.

DAILY TEMPERATURE, BATON ROUGE, MAY 10 TO JUNE 20, 1909.

Day.	Max.	Min.	Mean.
May 10......	83	57	70
May 11......	79	53	66
May 12......	85	55	70
May 13......	87	64	75.5
May 14......	90	70	80
May 15......	87	74	80.5
May 16......	86	68	77
May 17......	85	71	78
May 18......	85	65	75
May 19......	85	67	76
May 20......	82	69	75.5
May 21......	83	68	75.5
May 22......	89	67	78
May 23......	91	69	80
May 24......	89	70	79.5
May 25......	91	77	84
May 26......	90	72	81
May 27......	87	67	77
May 28......	89	69	79
May 29......	92	73	82.5
May 30......	92	75	83.5
May 31......	89	70	79.5
June 1......	88	73	80.5
June 2......	76	70	73
June 3......	87	69	78
June 4......	90	71	80.5
June 5......	91	70	80.5
June 6......	93	71	82
June 7......	93	73	83
June 8......	94	74	84
June 9......	92	75	83.5
June 10......	93	73	83
June 11......	89	74	81.5
June 12......	95	78	86.5
June 13......	96	75	85.5
June 14......	90	75	82.5
June 15......	90	71	80.5
June 16......	92	73	82.5
June 17......	96	76	86
June 18......	95	77	86
June 19......	93	73	83
June 20......	87	73	80

From June 20 until the latter part of September, the temperature, of course, averaged still higher. The daily mean from June 20 to September 20 varied from 79.5 to 91, with only one day below 80. The daily minimum for the same period ranged from 70 to 83, and only two days of that time was it as low as 70. Judging from the temperatures and the time when the anthracnose ceased to develop, it would seem that when the temperature reaches a daily mean of slightly above 80, with the minimum above 70, the critical temperature for the bean anthracnose has been reached. It would not be safe to draw a definite conclusion from this, however, on account of the many other factors which might influence the development of the disease.

The soil is also at a very high temperature during the summer months. Soil temperatures are not kept at any place in this region as far as I know, but in order to get some idea of how hot the soil gets, I made a few tests during one period of the summer. These could not possibly represent the maximum soil temperatures, for we had much hotter weather at other times during the summer. These temperatures were as follows:

TABLE 7.

SOIL TEMPERATURES.

Date. Hour.	Weather Condition.	Air Temp. Max. for Day.	Surface of Ground	2 in. Under Soft Earth	2 in. Under Packed Earth
July 29, 3:00 p. m.	Hot and sunshiny...	95	122	102	112
July 29, 4:30 p. m.	After slight rain....	95	96	97	98
July 30, 9:00 a. m.	Rain preceding night.	86	79	79	79
July 30, 3:00 p. m.	Cloudy, showers.....	86	88	87	87
July 31, 9:00 a. m.	Cloudy, ground wet..	89	84	82	82
Aug. 2, 9:00 a. m.	Hard rain preceding.	87	82	..	82

If the temperature factor is important in checking the disease, these high soil temperatures should work advantageously in checking the development of the disease on the cotyledons and young stems. In order to test this, a number of experiments were conducted.

On May 25, 1909, four rows of clean Wardwell's Kidney Wax seed were planted. The seed for two of the rows was treated with a suspension of anthracnose spores in water before planting. While ordinarily in the spring, in the field, or in the greenhouse in cooler weather, this would have given abundant infection, no spots containing anthracnose spores were found on the seedlings nor did any develop later on the plants.

A number of plots of diseased seed, ranging from 11 to 50 per cent spotted, were planted at various times during the summer to see if the disease would develop. These plantings did not consist of only a few seed, but were sufficient for a test. The smallest one consisted of four rows 110 feet long, and the largest about one-sixteenth of an acre. These were planted in June, July, August, and September. The young seedlings were examined carefully, but no spots containing developing anthracnose spores were found, nor did the plants develop anthracnose later. The lack of sufficient moisture was not the cause of lack of development, because, during most of the time, there was abundant rainfall.

On July 26, 1909, 100 spotted beans were carefully picked out. These all contained well developed anthracnose spots. These were planted in the garden at Baton Rouge. When the seedlings came up, these were pulled up and each one was examined microscopically for anthracnose spores, with the following results:

TABLE 8.

EFFECT OF TEMPERATURE ON ANTHRACNOSE DEVELOPMENT IN THE GROUND.

Date Examined	Total No. of Plants	Clean Seedlings	Spotted Seedlings	No. with Anthracnose	No. with Sterile Spots.	No. with Other Fungi*
July 31	43	26	17	2	14	1
August 3	46	26	20	2	6	12
August 5	1	1	..	..	..	..
Total	90	53	37	4	20	13

*The other fungi were Fusarium, Sterigmatocystis, Alternaria, and Penicillium.

The place where these beans were planted was in a low part of the garden, and, as there was considerable rainfall, the ground was wet during the experiment, thus decreasing the soil temperature to some extent. Yet, under these conditions, the small development of the anthracnose is remarkable.

Ninety of the 100 beans germinated, and of these 53 were clean. On the latter, it is evident that the disease did not extend deeper than the seed coats, and failed to develop further as the seed germinated. When the seed coats were shed, the cotyledons below were left clean. Thirty-seven of the young seedlings had spotted cotyledons, but on 20 of these the spots seemed to be perfectly sterile. The spots on the seeds of the latter evidently extended through the seed coats and into the cotyledons, before the seeds were placed in the ground. But further development of the disease was checked. The spots on the cotyledons of the young seedlings were merely smooth, sunken black spots, containing not a single anthracnose spore. These same spots, under cooler conditions, would have been covered with spores. Of the plants developing from the 100 diseased seed, only four of them had spots which contained anthracnose spores, and two of these had such a small number that it is questionable whether they were not some that were present on the seed when planted.

The effect of hot weather on the development of the disease on the cotyledons, is bound up with the question of the effect of other micro-organisms, a point which will be discussed later. The reason for the enumeration of the other fungi in the table will consequently be taken up at that time.

Other experiments in planting diseased seed and seed treated with anthracnose spores in the summer time in the laboratory have always failed to give a development of the fungus. Furthermore, fresh bean pods brought into the laboratory and sprayed with anthracnose spores in the hot weather have invariably failed to develop the disease, while others similarly sprayed in cooler weather produced spots in abundance after the normal period of incubation.

EFFECT OF OTHER MICRO-ORGANISMS.

Halsted has called attention to the fact that spotted seed rots much worse in the soil than clean seed, and, without doubt, this has been noticed by others. But what this rot is due to, or what the factors are that favor or retard the development of the rot have not previously been investigated.

The relation of the rot organisms was one of the first points that appeared when the study of the bean anthracnose was commenced. Spotted seed often showed a low per cent of germination and, furthermore, as a rule the spots that were present on the young cotyledons contained spores of other fungi instead of the anthracnose spores. In the field plantings during each season, the seedlings developing from diseased seed have shown a high per cent to have the spots filled with some other fungus than the anthracnose. The most common fungus to be found in the spots was a species of Fusarium, though species of Penicillium, Alternaria, Aspergillus, and Sterigmatocystis were not uncommon. I was not able to determine the species of Fusarium, but it seemed to be the same pink one that is so common on various dead plants. The Fusarium, as a rule, developed so abundantly on the cotyledons that it was usually difficult to find a seedling on which there was a development of the anthracnose spores. Of course, some would escape the attack of the Fusarium, as shown by the fact that isolated plants would later develop the disease in abundance.

The bean anthracnose is a comparatively slow-growing organism, and it can not stand competition on dead material. Any of the common saprophytic fungi will readily run it out. As the tissue of the cotyledon is only in a semi-living state, it constitutes a medium upon which the saprophytic forms can grow. They obtain a foothold in the spot caused by the anthracnose and readily run the latter out. The Fusarium does not develop alone in the spots caused by the anthracnose, as it is often able to find entrance at other places; but the anthracnose spot furnishes the best conditions for its development. The Fusarium spores may be on the surface of the seed when it is planted, as I have frequently had it to develop when diseased seed was planted in sterilized soil, but more often it gains entrance to the seed from the soil.

The relation of the soil organisms to the bean anthracnose is a different problem in the south from what it is in the north. In the north, a large per cent of the saprophytic organisms are killed out or reduced during the winter, resulting in a relatively small number of spores in the soil at planting time. This means that a relatively large per cent of the planted beans will not come in contact with them. However, in the south, where the winters are mild, the Fusarium and other fungi grow nearly the year around, and the soil is more or less thoroughly infected at planting time. However, even here the earliest plantings are freer from these forms than later plantings.

Having observed the rotting of the seed and the effects of the Fusarium on the young seedlings, some experiments were conducted in the greenhouse to get some more exact data on the question. The first experiment was started on February 1, 1909. Fifty ordinary six-inch pots were obtained and filled with good garden loam. These were numbered, divided in lots of five, and given the following treatment:

Pots 1-5. The soil was sterilized for one hour in the autoclave. Spotted bean seed was procured, washed for three minutes in a one-fourth saturated corrosive sublimate solution, rinsed in sterilized water, and then treated with a suspension of Fusarium spores in sterile water. The seeds, while still wet, were planted in the sterilized soil, five beans in a pot.

Pots 6-10. Soil sterilized for one hour. The spotted bean seed was treated with a suspension of Fusarium spores and planted while wet.

Pots 11-15. Soil sterilized for one hour. The spotted bean seed was washed for three minutes in a one-fourth saturated corrosive sublimate solution and planted without rinsing.

Pots 16-20. Soil not sterilized. The spotted seed was washed for three minute in a one-fourth saturated corrosive sublimate solution and planted.

Pots 21-25. Soil sterilized for one hour. The upper layer of the soil was treated with a suspension of Fusarium spores one day previous to planting. The spotted seed was planted without treatment.

Pots 26-30. Soil sterilized for one hour. The upper layer of soil was treated with a suspension of Fusarium spores at the time of planting. The spotted beans were planted without treatment.

Pots 31-35. Soil sterilized for one hour. The spotted seed was planted without treatment.

Pots 36-40. Soil not sterilized. The spotted seed was planted without treatment.

Pots 41-45. Soil sterilized for one hour. Healthy seed planted without treatment.

Pots 46-50. Soil sterilized for one hour. Healthy seed was wet with a suspension of Fusarium spores and planted.

In pots 1-40, five seeds were planted in each; in pots 41-50, six seeds in each. Davis White Wax seed was used in all the pots.

The spots on the young plants were examined microscopically. The results of the experiment are summarized in the following table:

TABLE 9.

EFFECT OF FUSARIUM AND SOIL STERILIZATION ON THE ANTHRACNOSE.

Pots No.	No. of Seed	No. of Plants	No. of Plants with Spots.	Spots with Fusarium*	Spots Entirely Fusarium
1- 5	25	23	16	2	0
6-10	25	23	19	7	4
11-15	25	19	10	0	0
16-20	25	15	12	0	0
21-25	25	22	20	15	7
26-30	25	21	12	4	2
31-35	25	23	19	0	0
36-40	25	5	2	0	0
41-45	30	28	0	0	0
46-50	30	28	0	0	0

In this experiment, all the spots that did not contain Fusarium spores contained an abundance of anthracnose spores.

There are two points which should be noticed in this table: First, notice the low per cent of germination of the diseased seed in non-sterilized soil (Pots 36-40), as compared to similar seed in sterilized soil (Pots 31-35). This shows that the anthracnose alone did not prevent the germination, but that there were organisms in the soil that could gain entrance to the diseased seed and rot them. In the seed washed in corrosive sublimate and planted in non-sterilized soil (Pots 16-20), it seems that the poison prevented the entrance of some of the rot organisms, though the percentage of germination here is still much lower than in the sterilized soil. Second, notice the presence of the Fusarium in those which were treated with Fusarium spores, especially in pots 21-25, in which the Fusarium was allowed to get a start before the seeds were planted. It must be borne in mind also, that those spots which contain both anthracnose and Fusarium spores when they come through the ground, generally become completely overrun by the Fusarium later.

---

*Some of these spots contained both Fusarium and anthracnose spores.

Other experiments gave similar results. In all cases where spotted seed was planted in soil treated with the Fusarium, many of the spots on the young seedlings contained nothing but Fusarium, while those planted in soil not treated produced plants with a good development of the anthracnose spores in most of the spots. These experiments, however, were disappointing in a way. While they showed that the Fusarium would eliminate a portion of the disease, it would not eliminate a sufficient amount of it to make seed or soil treatment practical.

The Fusarium seems to crowd out the anthracnose by its more rapid growth. It was thought at first that it might produce some toxic substance which would prevent the growth of the anthracnose, but some laboratory experiments seemed to disprove this. The Fusarium was grown for some time in bean bouillon. The liquid was then filtered through a Chamberland filter, and the sterile filtrate was added to other tubes of sterile media. The tubes were then inoculated with the anthracnose, with the result that it grew just as well in these as in the check tubes in which there was none of the filtrate.

The infection of germinating seed, cotyledons, or young stems, by means of anthracnose spores that may be on the seed or in the ground, is also greatly influenced by the rot organisms of the soil, both fungi and bacteria. To prove this, other pots were procured and filled with soil. Part of these were sterilized and part were not. The seed used for planting was all healthy, but it was treated with a suspension of anthracnose spores, some in a suspension in sterile water and the rest in potato bouillon. The following table gives the soil and seed treatment and the results of the experiment.

TABLE 10.

THE EFFECT OF SOIL STERILIZATION ON INFECTION AND SEVERITY OF THE ANTHRACNOSE.

Pots No.	Soil Treatment	Seed Treatment	No. of Seed	No. of Plants	No. Plants Spotted	No. Plants Killed*
51, 52	Sterilized 1 hr....	Spores, sterile water.......	20	18	18	18
53...	Sterilized ½ hr...	Spores, sterile water.......	10	10	10	10
54...	Not sterilized....	Spores, sterile water.......	10	5	4	1
55...	Sterilized 1 hr....	Spores in potato bouillon..	10	6	6	0
56, 57	Sterilized ½ hr...	Spores in potato bouillon..	20	18	16	11
58, 59	Not sterilized....	Spores in potato bouillon..	20	2	1	0
60...	Not sterilized....	Seed wounded; spores in water..................	10	3	3	1
61...	Sterilized ½ hr...	Seed wounded; spores in water..................	10	9	9	7
62...	Sterilized 1 hr....	Seed wounded; spores in water..................	10	9	9	7

An examination of the table will show that in the sterilized soil 70 seeds out of 80 (87.5 per cent) were able to germinate and push to the surface of the ground, while in the non-sterilized soil only 10 out of 40 (25 per cent) were able to do this. This shows again the effect of the various rot organisms in the non-sterilized soil. However, only 17 plants out of the 70 (24 per cent) were able to stand the effect of the anthracnose, the others rotting off at the surface of the ground; while in the non-sterilized soil eight out of the ten plants lived (80 per cent), only two rotting off. If the seed is infected with anthracnose spores, and these are not in competition with other micro-organisms, the anthracnose is able to cause a very high mortality among the small seedlings. However, if the rot organisms are in the soil, these will greatly reduce the severity of the anthracnose attack. Of course, these will prohibit the germination of many seed that are infected with the anthracnose, but this is a benefit from the standpoint of the control of the trouble. Plate IX shows two pots from this experiment, one with the sterilized and the other with the non-sterilized soil. All the plants are dead in the sterilized soil, with all parts covered with anthracnose spores, while the plants in the non-sterilized soil have a much better appearance. These also contain small anthracnose spots, but the severity of the attack has been greatly lessened.

---

*A large number of plants, especially in the sterilized soil, rotted down just after germination with the anthracnose.

From the standpoint of the bean raiser, the effect of the soil organisms is very important. While the disease is not entirely eliminated in the field, it is reduced from a condition that would have been general, if all the spotted seed planted had grown, to a localized one. With the disease reduced to a localized condition, it can usually be kept in check with the precautions which will be discussed later under "Control."

RELATION OF THE FUNGUS TO OTHER ANTHRACNOSES.

Much has been written in regard to the limits of species among the anthracnoses. Formerly, to a large extent, anthracnoses were determined by the host; that is, it was thought that the forms found on different hosts were distinct. But of late years, since these have been studied carefully, the ideas concerning the species have been modified considerably. At present, some go so far as to say that we have but one or two species of these forms that are connected with the Glomerella perfect stage. Shear and Wood (29) would place all of these forms, with perhaps the exception of the cotton anthracnose, in one species, with only a varietal difference at the most between them. As long as we do not know what a species is, and we hardly have two botanists who have the same idea in regard to the limits of species, the final disposition of forms such as we have in the group of anthracnoses, is indeed a question. We know that there are differences between some of the anthracnoses, differences that are constant; furthermore, we know that some of the anthracnoses are peculiar to some host plants and cannot be transferred to others. Whether these differences are specific differences is a question, but it is absolutely necessary that they should be designated in some manner. It will not do to call them all Glomerella rufomaculans; and the use of a varietal name in the form of a trinomial is, to say the least, very inconvenient. For me it seems better to call the different forms different species until we have better ideas of the limits of species in this group. Of course, if a form will grow and does grow normally on a number of different hosts, as the form on apple is known to do, it can have but one name. But if a form is peculiar to a single host and will not grow on others, it should have a different name from any anthracnoses that might be found on these other hosts. The bean anthracnose seems to be such a form, and, consequently, is considered as a distinct species in this bulletin. The reasons for this are the differences in cultural characteristics which have been discussed, and the results of cross inoculation experiments, which will be described later.

Halsted (15) seems to have been the first one to try cross inoculation experiments with the bean anthracnose. He inoculated a citron with the anthracnoses from the bean and watermelon. According to his statement, the spots caused by the two fungi grew together, and it was impossible to tell the boundary between them. From this experiment he claimed that the bean and watermelon anthracnoses were the same, calling them both Colletotrichum lagenarium. As far as I know, the experiment has never been duplicated by others.

C. O. Smith (31) tried some careful experiments in inoculating the bean anthracnose on the watermelon, and the watermelon anthracnose on the bean, but with no infection in either case. Consequently he claimed that the two fungi were distinct. Miss Stoneman (33), from a study of cultural characters, arrived at the same conclusion. Sheldon (30) also, was unable to infect the bean by using the watermelon anthracnose.

The cross inoculations which have been tried during this investigation have been with the forms from the bean, cotton, fig, pepper, and rose. The work has included the inoculation of the bean anthracnose on hosts other than the bean, and the inoculation of anthracnoses from other hosts on to the bean. The inoculations were all made in the greenhouse, where the conditions could be controlled. The results of these inoculations are briefly given in the following paragraphs:

Experiment March 2, 1909. Sprayed bean anthracnose spores on young bush bean plants, alfalfa, and cotton plants, protected by bell jars, with the following results:

On bush beans—abundant infection.

On alfalfa—no infection.

On cotton—no infection.

Experiment March 22, 1909. Sprayed bean anthracnose spores on young bush beans, pole beans, Lima beans, and garden peas, with the following results:

Bush beans—abundant infection.

Lima beans (variety, Small White Pole,)—several small spots developed.

Pole beans (variety, Nox All,)—no infection.

Garden peas—no infection. On some of the garden peas the wax was rubbed off the leaves so that the water containing spores would adhere better, but with no better results.

Experiment April 5, 1909. Sprayed the bean anthracnose on young bush bean, pole bean, Lima bean, and cucumber plants, with the results given in the table below. The pole beans were of the variety Nox All, and the Lima beans the Small White Pole Lima.

TABLE 11.

INFECTION OF PLANTS WITH BEAN ANTHRACNOSE.

Plants used.	April 10.	April 11.	April 12.	April 17.
Bush beans	Slight infect.	Abundant infec.	Abundant infec.	Abundant infec.
Pole beans	No infection	No infection	No infection	Found one spot
Lima beans	No infection	No infection	Slight infection	Slight infection
Cucumber	No infection	No infection	No infection	No infection

Other attempts to inoculate cucumbers at various times, using leaves, stems and fruits, were unsuccessful.

Experiment March 22, 1909. Sprayed young bush bean plants with the bean, fig and pepper anthracnoses, with the following results:

Bean anthracnose gave abundant infection.

Fig anthracnose gave no infection.

Pepper anthracnose gave no infection.

Experiment May 4, 1908. Placed freshly picked bean pods in moist chambers and sprayed on them cultures from the bean and from the rose, with the following results:

Bean anthracnose gave abundant infection.

Rose anthracnose gave no infection.

Experiment February 10, 1909. Planted healthy Davis White Wax beans, which were wet with suspensions of spores of the bean, fig and cotton anthracnoses, in pots in the greenhouse. The amount of germination, and the amount of disease on the young plants is given in the following table:

TABLE 12.

EFFECT OF DIFFERENT ANTHRACNOSES ON GERMINATING SEED.

Anthracnose	No. of Seed	No. of Plants	No. with Spotted Cotyledons at First	No. Spotted Feb. 23.	No. Spotted Feb. 25
Bean	25	21	9	19	20
Cotton	25	24	1	0	0
Fig	25	18	1	1	0

The fig anthracnose, especially, seemed to be able to grow on the substance of the bean seed, for several of the beans that rotted in the ground without germination were covered with the spores of this fungus. Both the cotton and the fig anthracnoses were able to attack the semi-living cotyledons of the germinating beans, and in one case, with each, cotyledons spotted with these were carried above the ground. These spots, however, did not look at all typical of bean anthracnose spots, though they contained spores in abundance. These spots did not develop further; the cotyledons finally fell off and the plants were left clean. But with the bean anthracnose there was a good development of the disease on the cotyledons and, later, abundant development on the stems and leaves.

This experiment was repeated with the bean and fig anthracnoses, using sterilized soil instead of the non-sterilized, as used in the previous one. In this case, practically all the young plants growing from the seed treated with the bean anthracnose were spotted and the later development of the disease on the leaves and stems was abundant. The plants that grew from the seed treated with the fig anthracnose had no definite spots, but several had irregular decayed areas containing anthracnose spores. But when the cotyledons fell off, the plants were left clean.

A similar experiment was also tried using the bean and rose anthracnose with very similar results. Plate XI, figure 1, shows bean cotyledons affected with the rose anthracnose. With this anthracnose, as with the fig, the bean plants were left clean when the cotyledons fell off.

From the experiments described above, and from the work of other investigators, there seems to be no doubt that the bean anthracnose is a specialized form among the anthracnoses, at least from a physiological standpoint. It is practically confined to the host, Phaseolus vulgaris, though it will take to a slight extent on at least some varieties of the Lima bean, Phaseolus lunatus. It has also been reported on the Scarlet Runner, Phaseolus multiflorus, by Massee (23). It has also been reported on the cowpea, Vigna catjeng, by Chester (4), but the proof of the identity of the form is far from conclusive. The bean anthracnose is certainly distinct from the fruit rot anthracnoses.

CONTROL.

A large part of the work that has been done by workers in plant pathology on the bean anthracnose has been along the line of control. This has included work on spraying, seed treatment, the use of clean seed, the eradication of diseased plants, proper cultivation, the use of resistant varieties, etc. In the light of our present knowledge of the disease, a discussion of these different factors which tend to increase or decrease the severity of the disease will not be out of place.

Natural Factors.

Under Louisiana conditions, the effect of the natural factors of control—heat and micro-organisms—is very important. These have both been discussed in earlier pages of this bulletin, but little has been said in regard to their relation to control. Under ordinary conditions, these decrease the severity of the disease considerably. But these two factors are not made as much use of as they should be. Beans are generally grown at the time when these factors are not especially important. To make beans profitable, they must be planted as soon as there is little danger of frost, this being during the first half of March. This brings the beans into marketable shape during the last of April and the first of May. This is just the time when the natural factors are of the least importance. The cool and wet weather of the spring is most favorable for the development of the anthracnose, and by planting so early in the spring, there is not so much chance for the soil organisms to eliminate the disease on the young seedlings. The question is, how can we utilize these natural factors to better advantage? This can be done by growing some beans during the warmer part of the year and saving the seed for planting the following spring. It has been demonstrated, especially by the work of Whetzel (37), that the disease can be controlled by the use of clean seed. If clean seed is used and the disease is not introduced into the field later, there will be no development of the anthracnose. Plantings of clean seed on the Experiment Station grounds at Baton Rouge gave an absolutely clean crop, though there were badly diseased plots less than 100 yards distant. Now, if we can use the natural factors of control, in raising beans that can be used for seed purposes, we have progressed towards the solution of the problem. In Louisiana Bulletin 116, the planting of a small plot in the fall for seed purposes was advised. During two seasons' work in Louisiana, I have not seen a spot on a bean due to the anthracnose later in the season than June. There is often some spotting due to the blight, but the anthracnose is lacking. According to the statements of some bean growers, it does appear occasionally in the fall, but not usually. And it is more than possible that these truckers had confused the anthracnose with the blight.

There is, however, liable to be some difficulty in raising a crop of beans in the fall. Beans are accustomed to a cool climate and will not set pods during the hot summer months. In order to produce a crop in the fall, it is necessary to plant the beans late enough in the season, so that the weather will be fairly moderate at blooming time. This will allow the beans to be planted in the warm weather, thus allowing the heat and soil organisms to kill out the disease before the cool weather begins. If the frosts do not come too early, it is possible to raise seed in the fall. However, there is always a chance of the frosts killing the plants before the pods mature. However, some seed has been raised during the past two years in this way.

During 1909 experiments were conducted at Baton Rouge to test the possibility of raising fall seed. Plots were planted at intervals of two weeks during the summer, beginning about the first of July. All of the early plantings were, of course, failures on account of the hot weather. No pods set and finally the plants died. The planting made July 29, was the first that set any pods, and this was too early for the best results. However, the summer of 1909 was exceptionally hot and the warm weather continued longer than usual in the fall. It is possible that in the more sandy parts of the State, as in Tangipahoa parish, early plantings would do better than at Baton Rouge. Not alone were we handicapped by the hot weather during 1909, but also by the hurricane of September 20. This storm nearly destroyed all the plants that we had on the station grounds, breaking many off, defoliating many, and washing the soil away from the rest, so that most of them had the roots exposed. The recovery of the plants took place very slowly. Consequently we did not gather a great deal of seed, but what we did gather was perfectly free from anthracnose. Not an anthracnose spot developed through the summer or fall in any of these plots, though seed as bad as 50 per cent spotted were used in some of them.

Experiments in growing fall seed will be continued next season. Also we intend to try planting beans later in the spring, so that they will mature in the summer, and see if it is not possible to eliminate the disease in the seed in this manner. A few preliminary experiments in this have given good results.

Practically all of the beans that are raised in Louisiana are grown from northern grown seed. Truckers, as a rule, seem to think that southern grown seed will not be as productive or early as the northern seed. However, from experiments conducted at the Experimental Station a few years back, there seems to be no ground for this belief (34). This being the case, it would seem that the home production of seed would be advisable for the Louisiana trucker. Even if he does not try to grow his seed during the warm weather and saves his seed from his spring crop, he will have cleaner seed than he usually gets from the north.

CULTIVATION.

The effect of working the plants while wet with rain or dew has been discussed in Bulletin 116, and the details need not be repeated. It is enough to say that in a field where the disease was at first localized in narrow strips across the field and worked only while the plants were dry had 8.8 per cent more clean pods than a similar field that was worked while the plants were wet. It is an old saying in bean growing sections that cultivation of the plants while they are wet will spot them; and it is a saying that is well founded.

The cultivation of beans should be thorough, as thorough as with any other crop. It is often the case that the cultivation of this crop is slighted, especially if there is other work to do at the time. Cultivation will not only increase the yield, but will also hasten the formation of the beans, thus affording a shorter time for the beans to become infected with the disease.

FERTILIZATION.

The effect of the fertilizers on the bean anthracnose has not been studied enough to furnish any reliable data. But with this, as with cultivation, anything that tends to force the plants will help in controlling the disease. The effect of barnyard manure on the development of the plants and their resistance to the heat of summer, was observed in some of the plots described above. Two plots were planted on July 29. One of these had a good treatment of stable manure during the spring, while the other plot had no fertilizer. The unfertilized plot died out very badly during the summer, the plants setting no pods. The plants in the fertilized plot died somewhat, but they were much healthier than in the other plot and set a fair crop of pods. In order to obtain a good crop of beans in the fall, it seems very essential to have the ground well enriched with stable manure. Just what the action of the stable manure was, is a question. It may have helped the physical condition of the soil, by increasing the amount of humus in it. This would tend to keep down the temperature.

SEED TREATMENT.

Considerable work has been done on seed treatment, but no treatment has been devised which seems to be practical. Beach, Halsted and others have treated the seed with various chemicals, as Bordeaux mixture, other copper compounds, mercuric chloride, iron sulphate, lysol, etc., but with the general result that the disease was not entirely killed out with chemicals weak enough to cause no harm to the germinating power of the seed. Treatment with hot water, as described by Beach, seems to have given the best results. This treatment has also been recommended for killing the blight bacteria on the seed.

Some preliminary work on seed treatment was commenced during the summer of 1909. First, healthy seed was treated with water at various degrees of temperatures for definite periods to see how much the seed itself would stand. After the seed was treated, it was planted in the field. Fifty seed were used in each treatment. The treatment and the results were as follows:

TABLE 13.

EFFECT OF SEED TREATMENT ON GERMINATION.

No.	Treatment of Seed.	Germination, per cent.
1.	Seed untreated	96%
2.	Bordeaux mxture 5 min., solution drying on seed	94
3.	In water at 50° C. for ten min	96
4.	In water at 60° C. for 5 min	82
5.	In water at 70° C. for 1 min	90
6.	In water at 80° C. for 1 min	20
7.	In water heated gradually to 50° C., time necessary 10 min	88
8.	In water heated gradually to 60° C., time necessary 15 min	58
9.	In water heated gradually to 70° C., time necessary 20 min	0
10.	In water heated gradually to 50° C., and held at that point 5 min	86

From this it would seem that seed treated in water at 50° C. (122° F.) for ten to fifteen minutes has little or no effect on germination. Furthermore, this short treatment is not sufficient to cause the seed coats of the beans to loosen. If the seed slips its coat, it is worthless for planting.

Having some idea of the resistance of the seed itself to treatment, some diseased seed was treated and planted in pots. As the time when this planting was done was in the summer, most of the pots were placed in a cool basement, where the effect of the high temperature would be eliminated as far as possible. However, a few were left in the greenhouse, where it was warm. The treatment of seed and soil, the location of the plants, and the results are given in Table 14. The numbers under Seed Treatment refer to the numbers in Table 13.

TABLE 14.

EFFECT OF SEED TREATMENT ON BEAN ANTHRACNOSE.

No. of Seed	No. of Plants.	Soil Treatment.	Location.	Seed Treatment.	Spotted Plants.	No. Anthracnose.	No. Fusarium.	No. Other Fungi.
20	16	Sterilized	Cool room	1	6	4	2	0
20	15	Sterilized	Cool room	2	9	5	1	3
20	15	Sterilized	Cool room	10	13	1	10	2
20	11	Sterilized	Cool room	4	11	0	7	4
20	13	Sterilized	Cool room	5	10	0	6	4
20	17	Sterilized	Warm room	1	13	0	3	10
20	8	Not sterilized	Cool room	1	5	3	0	2
20	16	Not sterilized	Warm room	1	12	2*	2	8

This table shows that the plants that grew from the seed treated with hot water had a smaller per cent diseased than from the untreated seed. While this shows that this treatment may be beneficial, it was not conducted on a large enough scale to be conclusive. This table also shows again the effect of hot weather in reducing the anthracnose.

Considering that a considerable per cent of the anthracnose on diseased seed under Louisiana conditions will be eliminated by the natural factors, it may be that seed treatment with hot water will help materially in decreasing the remainder. Barlow (18) has also pointed out that the blight bacteria may be killed on the seed by the hot water treatment. If this is the case, seed treatment may become an important factor in Louisiana in the control of bean diseases. But at present more data is necessary.

---

*Only a very few scattering spores and these very much shrunken and vacuolate. Without doubt these were some of the spores that were on the seed before it was planted.

SPRAYING.

Spraying has been advocated by many, and is still being advocated by some, as a remedy for bean diseases. Halsted has perhaps carried out the most work in this, but the evidence he has obtained is somewhat conflicting. Whetzel (37) from his work in New York, claims that spraying with any spray machinery we have at present is not satisfactory in controlling the bean anthracnose.

No experiments to prevent the anthracnose in Louisiana by spraying have been tried. Some experiments to prevent the blight and to decrease the attack of insects were tried in the summer of 1909. Bordeaux mixture and arsenate of lead were used. On account of the very frequent rains in this region, it is necessary to spray on an average of about once a week. This spraying not only decreased the blight, but also protected the plants to some extent from the effects of the hot weather. The unsprayed plots in many cases died early, while the sprayed plots held their green color for some weeks later.

We can hardly expect to control the anthracnose in Louisiana by spraying. Even in dryer regions it has proven to be unsatisfactory.

RESISTANT VARIETIES.

No variety of bush beans, as far as I know, is entirely resistant to the anthracnose, and there is no reliable data in regard to the comparative resistance of the different varieties. Several investigators have grown different varieties side by side and then determined the amount of anthracnose on the different ones. But experiments of this kind are of little value. The mere fact that one variety spots badly under these circumstances while another spots but slightly, shows but very little. The chances are that the seed of the variety that spotted badly were much more diseased to begin with than the other. The only way to get reliable data on this point would be to give each variety a thorough spraying with a suspension of spores. All the wax varieties that I have worked with, including Wardwell's Kidney Wax, Davis' White Wax, Refugee Wax, and Challenge Black Wax, have been very susceptible. The small white bean, commonly called the Navy bean, is also very susceptible. The Valentine, a green podded variety, is slightly more resistant. The leaves and stems of the Nox All, a pole variety, have shown highly resistant qualities. No inoculations were tried on the pods of this variety. Hodson's Wax is getting a reputation in the trucking districts of being more or less resistant to this disease, but it certainly is not entirely resistant, as I have observed the anthracnose on this variety at Ponchatoula. No inoculations have been tried on this variety, and it is questionable whether the freedom of the disease is not more or less due to cleaner seed.

SOURCE OF SEED FOR PLANTING.

Practically all the seed used for planting in Louisiana is northern grown seed, coming principally from Michigan and Colorado. The greater part of it comes from Michigan, though of late years Colorado seed is becoming popular. The Michigan seed comes from a state where anthracnose is very severe, and, as a result, the per cent of diseased seed in that obtained from that region is often large. In Colorado, the seed is grown in the irrigated regions, and the growers claim that the anthracnose is rare. During the past season, at least, plants grown from Colorado seed in Louisiana were freer from the anthracnose than most other seed. However, plants grown from Colorado seed were much more severely affected with the blight than the other seed, so it is a question whether there was anything gained by the use of this seed.

FURTHER WORK ON BEAN TROUBLES.

It is expected that the work on bean troubles will be continued at the Louisiana Station, being principally along the following lines:

1. Experiments on raising home-grown seed in the late spring and fall in order to get clean seed for planting.
2. Experiments to determine whether seed grown in the south is inferior in earliness or yield to northern-grown seed.
3. To test the efficiency of sprays as a control for the blight.
4. To test the efficiency of the hot water treatment of seed in eliminating the anthracnose and blight.
5. Further experiments in transferring the bean anthracnose to other hosts, and other anthracnoses to the bean.

SUMMARY.

Briefly the results of this investigation may be summed up as follows:

1. The bean anthracnose is a disease which causes a spotting of all parts of the bean plant above ground.

2. The disease is practically confined to varieties of Phaseolus vulgaris, though plants of at least some varieties of Limas will become spotted.

3. The period of incubation of the fungus is from four and one-half to six days, if the conditions for growth are favorable.

4. The disease is carried over from season to season in the seed, by means of resting mycelium and spores. The spores are present either on the surface of the diseased spots, or between the cotyledons, or in special enclosed pycnidia in the tissue of the bean.

5. Spores on the seed and in the seed are capable of retaining their virulence until planting time.

6. There is little difference in the viability of the spores whether they are dried down in the mucilaginous matrix which surrounds them, or whether they are freed from this.

7. The method of spore germination depends upon the medium, the number of spores in the medium, and the age of the spores.

8. The fungus will not stand a high per cent of acidity in the medium, thus differing from many other anthracnoses.

9. The fungus will not tolerate a continued high temperature, and consequently is killed out during the summer months in Louisiana.

10. Other micro-organisms in the soil, especially a species of Fusarium, easily gain entrance to the diseased seed and either rot the seed entirely or run out the anthracnose in the spots.

11. The natural factors, heat and micro-organisms, are very important in the control of the disease under Louisiana conditions, and it is thought that the proper use of these in growing seed for planting will greatly decrease the trouble.

BIBLIOGRAPHY.

The following bibliography does not include all references to this disease; only those mentioned in the text and a few others of importance:

1. Atkinson, G. F., Some observations on the development of Colletotrichum lindemuthianum in artificial cultures. Bot. Gaz. *20*:305-312. 1895.
2. Beach, S. A., Some bean diseases. N. Y. Agr. Exp. Sta. Bull. *48*. 1892.
3. Briosi and Cavara, Colletotrichum lindemuthianum (Sacc. and Magn.) Br. and Cav. I. Funghi parasiti della pianti coltivate ed utile, No. 50, Pavia Italy. 1889.
4. Chester, F. D., Diseased cowpea seed. Del. Agr. Exp. Sta. 6th Report, *1893*:110-111. 1894.
5. Craig, J. (Treatment of Bean Anthracnose). Can. Expt. Farms Rep. *1897*:110-120.
6. Edgerton, C. W., The physiology and development of some anthracnoses. Bot. Gaz. *45*:367-408. 1908.
7. ———, Preliminary report on the anthracnose or pod spot disease of beans. La. Agr. Exp. Sta. Bull. *116*. 1909.
8. Fawcett, H. S., Bean anthracnose. Fla. Agr. Exp. Sta. Rep. *1906*:XXI-XXII. 1907.
9. Ferris, E. B. (Bean anthracnose). Miss. Exp. Sta. Bull. *101*:9. 1907.
10. Frank, B., Ueber einige neue und weniger bekannte Pflanzenkrankheiten. Ber. der deutschen botan. Gesell. *1*: 31-34. 1883.
11. Fulton, H. R., Diseases of pepper and beans. La. Exp. Sta. Bull. *101*:1-21. 1908.
12. Gain, E. (Studies on bean anthracnose). Compt. Rend. Acad. Sci., Paris, *127*:200-204. 1898.
13. Galloway, B. T., Anthracnose of the bean. U. S. Dept. of Agr., Div. of Botany, Bull *8*. 1889.
14. Halsted, B. D. (Bean anthracnose). N. J. Exp. Sta. Rep. *1891*:284-288. 1892.
15. ———, Identity of anthracnose of bean and watermelon. N. J. Exp. Sta. Rep. *1893*:347-352. 1894.
16. ——— (Bean anthracnose). N. J. Agr. Exp. Sta.
    Rep. *1894*:294-302, 335-336. 1895.
    Rep. *1895*:283-292. 1896.
    Rep. *1896*:328-332, 356, 363, 368, 389. 1897.
    Rep. *1897*:309-314, 351-354. 1898.
    Rep. *1898*:309-312. 1899.
    Rep. *1899*:379-382. 1900.

Rep. *1900*:419-421. 1901.
Rep. *1901*:389-390. 1902.
Rep. *1903*:485. 1904.

17. ———, Bean diseases and their remedies. N. J. Exp. Sta. Bull. *151*. 1901.
18. Harrison, F. C., and Barlow, B., Some bacterial diseases of plants prevalent in Ontario. Ont. Agr. College Bull. *136*. 1904.
19. Harvey, F. L., Bean anthracnose. Maine Exp. Sta. Rep. *1893*:152-153.
20. Hasselbring, H., The appressoria of the anthracnoses. Bot. Gaz. *42*:135-142. 1906.
21. McCarthy, G. (Gloeosporium on cowpeas). N. C. Exp. Sta. Bull. *98*:151.
22. ——— (Bean anthracnose). N. C. Exp. Sta. Bull. *84*:14. 1892.
23. Massee, G., French bean canker. Gard. Chrn. 3 ser., *23*, No. 594:293. 1898.
24. Rolfs, P. H., Anthracnose of the bean. Fla. Exp. Sta. Rep. *1896*:48-49.
25. Rolfs, F. M., Bean Anthracnose. Fla. Exp. Sta. Rep. *1905*:30.
26. Saccardo and Magnus, Gloeosporium lindemuthianum n. s. Michelia *1*:129. 1878.
27. Scribner, F. L., Anthracnose of the bean. U. S. Dep't Agr., Sec. Veg. Path., Rep. *1887*:361-364.
28. ———, Anthracnose of the bean. Orchard and Garden *XI*:193-194. 1889.
29. Shear, C. L., and Wood, Anna K., Ascogenous forms of Gloeosporium and Colletotrichum. Bot. Gaz. *43*:259-266. 1907.
30. Sheldon, J. L., Diseases of melons and cucumbers. West Va. Exp. Sta. Bull. *94*. 1904.
31. Smith, C. O., Bean anthracnose. Del. Exp. Sta. Bull. *63*:24-28. 1904.
32. Stone, J. L., Commercial bean growing in New York. Cornell Exp. Sta. Bull. *210*. 1903.
33. Stoneman, Bertha, A comparative study of the development of some anthracnoses. Bot. Gaz. *26*:69-120. 1898.

34. Stubbs, W. C., Burnette, F. H., and Watson, Eugene, Home grown vs. purchased seed. La. Exp. Sta. Bull. *68.* 1902.

35. Viala, P., and Pacottet, P. (Investigations on grape anthracnose). Rev. Vit. *24:*433-439, 489-496, 517-523, 573-580, 601-608, 657-663. 1905. *25:*89-91, 341-347, 369-375. 1906.

36. Whetzel, H. H., Some diseases of beans. Cornell Exp. Sta. Bull. *239.* 1906.

37. ———, Bean Anthracnose. Cornell Exp. Sta. Bull. *255.* 1908.

EXPLANATION OF PLATES.

PLATE I. Colletotrichum lindemuthianum on pods of cultivated beans. Spots produced by inoculation.

PLATE II. Colletotrichum lindemuthianum, showing spots on under side of leaf and on petiole.

PLATE III. Colletotrichum lindemuthianum, showing spots on cotyledons.

PLATE IV. Colletotrichum lindemuthianum, showing spots on the stems.

PLATE V. Colletotrichum lindemuthianum. Fig. 1: The crumpling of the leaves due to the fungus. Fig. 2: Cross section of diseased pods.

PLATE VI. Colletotrichum lindemuthianum, showing very old spots on the stems.

PLATE VII. Colletotrichum lindemuthianum. Fig. 1: The spots on the seed. Fig. 2: Cross section of a spot on a pod, showing localized condition and the shrunken tissue.

PLATE VIII. Effect of inoculation on young bean plants. The plants on the left were sprayed with a suspension of spores, the photograph being taken the second day after the spots appeared. The plants on the right were not inoculated.

PLATE IX. Effect of sterilized and non-sterilized soil on the development of the anthracnose. In pot on left, the soil was sterilized and seed wet with a suspension of anthracnose spores. All plants have rotted off with the disease. In pot on the right, the soil was not sterilized, otherwise the treatment was the same. These plants show a much weaker infection.

PLATE X. Effect of non-sterilized soil on spotted and clean seed. The pot on the left was planted with clean seed, the one on the right with spotted seed.

PLATE XI. Fig. 1: Shows spot on a cotyledon produced by the rose anthracnose. Fig. 2: Shows the development of the Fusarium in the anthracnose spots on the cotyledons.

PLATE XII. Successive stages in the development of the acervulus of the bean anthracnose on bean pods. Fig. 1: A collection of a few mycelial threads in the epidermal and sub-epidermal cells. Fig. 2: The mycelial threads shown in the previous figure have given rise to a number of hyphal threads which lie nearly perpendicular to the surface of the bean. The increased growth of these raise the cuticle. Figs. 3 and 4: Later stages of the same. The hyphal threads which become the conidiophores, increase in number. Fig. 5: Later stage. The beginning of spore formation under the still unbroken but raised cuticle. Fig. 6: Still later stage, showing a large acervulus, spore formation, and the formation of a stroma at the base.

PLATE XIII. Figs. 1 and 3: Later stages in the development of the acervulus. Fig. 1: The ruptured cuticle still keeps the exudation of spores confined to a small opening. Fig. 3: The cuticle is entirely thrown aside. Figs. 2 and 4: Cross section of a diseased spot on the seed. Fig. 2 shows two pycnidia filled with spores, buried in the tissue of the bean. Fig. 4 shows one of these pycnidia much enlarged, showing conidiophores and spores.

PLATE XIV. Spore and mycelial characters. Fig. 1: Normal appearance of spores. Fig. 2: Vacuolate spores, first stage of deterioration. Fig. 3: Later stage than preceding. Spore contents broken away from the spore wall and collected in masses in the center. Spores not viable. Fig. 4: Normal germination of spores in nutrient media. Fig. 5: First stage in germination of spores that are too much crowded in the nutrient media. Fig. 6: Later stage of the same. Fig. 7: Still later stage of the same. Shows the formation of spores on the much swollen spore. Fig. 8: The germination of spores that have nearly lost their viability, in nutrient media. Fig. 9: The formation of conidia. Fig. 10: Appressoria that developed in water. Fig. 11: Appressoria that developed in cultures. Fig. 12. Anastamosing of mycelium from germinating spores. Fig. 13: The large, colored, thick walled threads that make up the crust or stroma in the old cultures. Fig. 14: An earlier stage of the preceding.

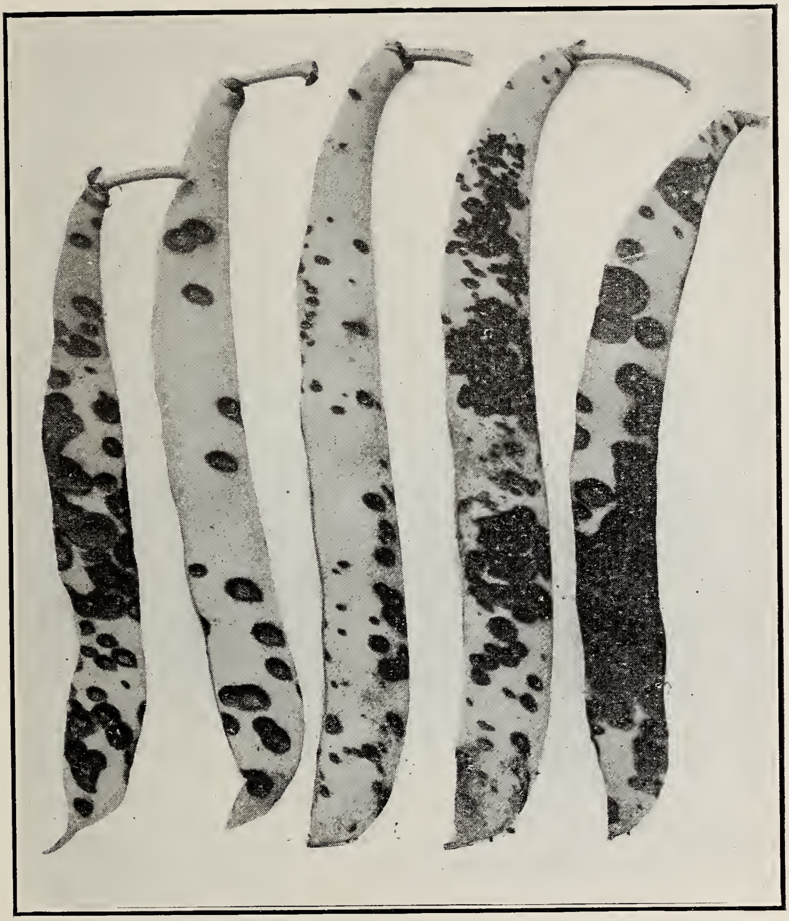


Plate I.

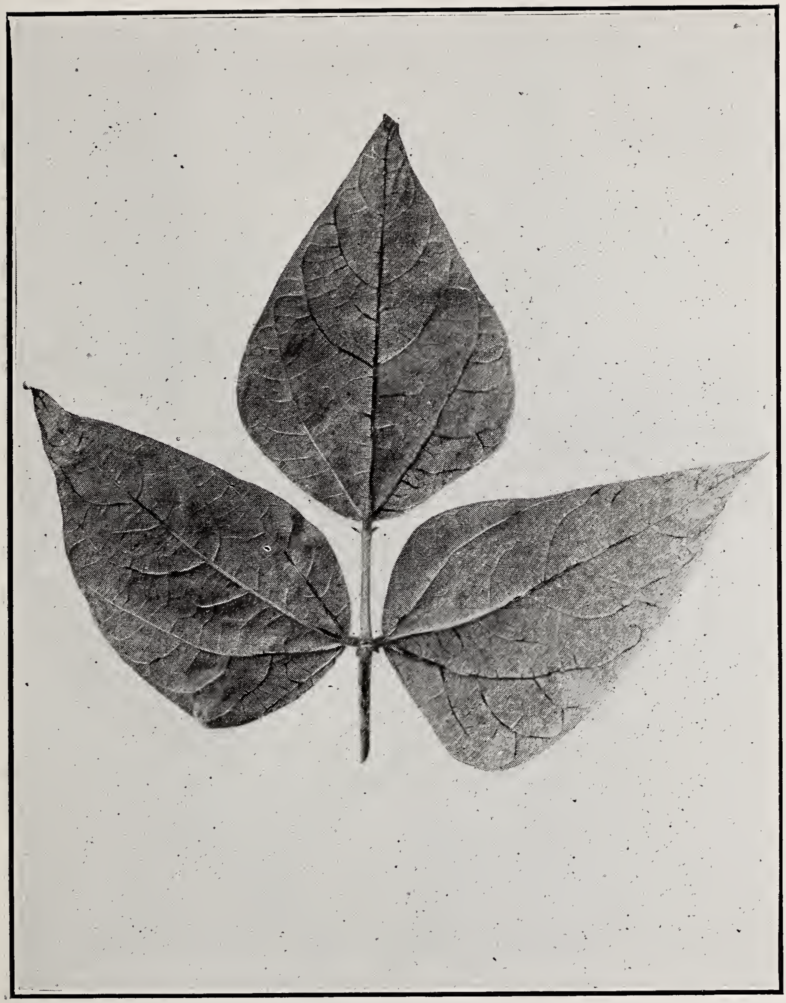


Plate II.

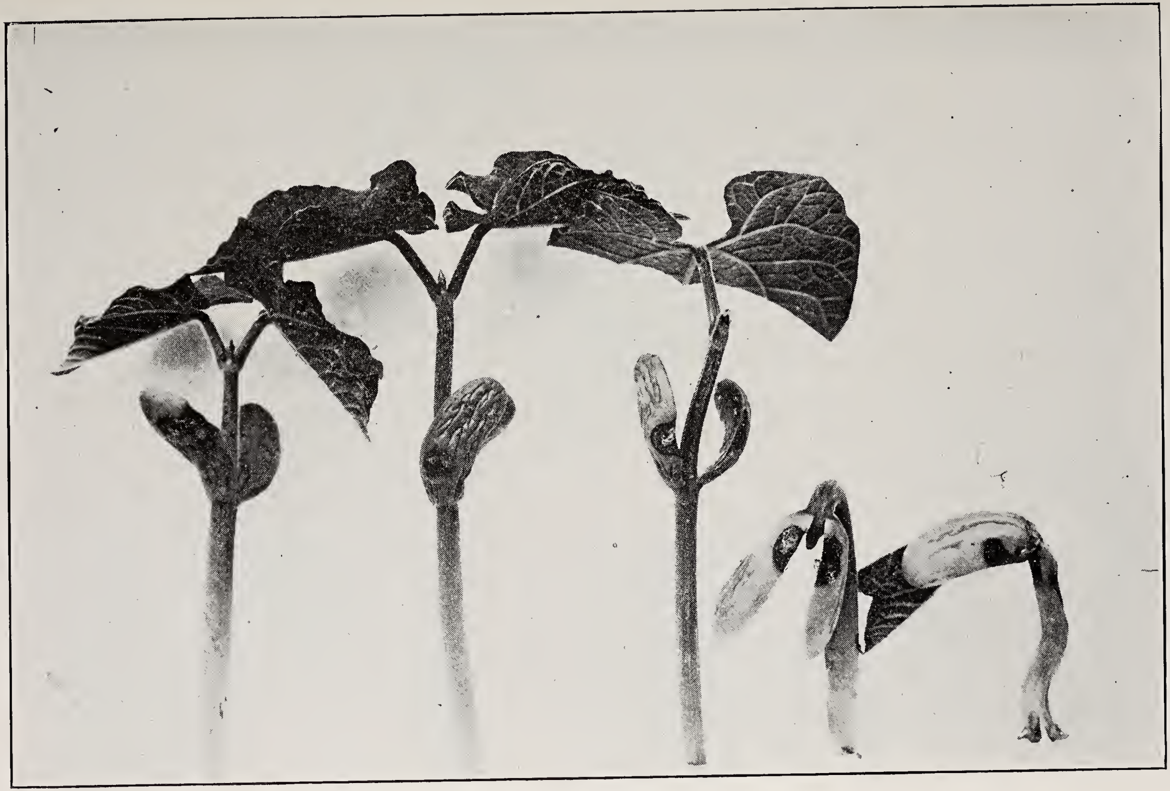


Plate III.

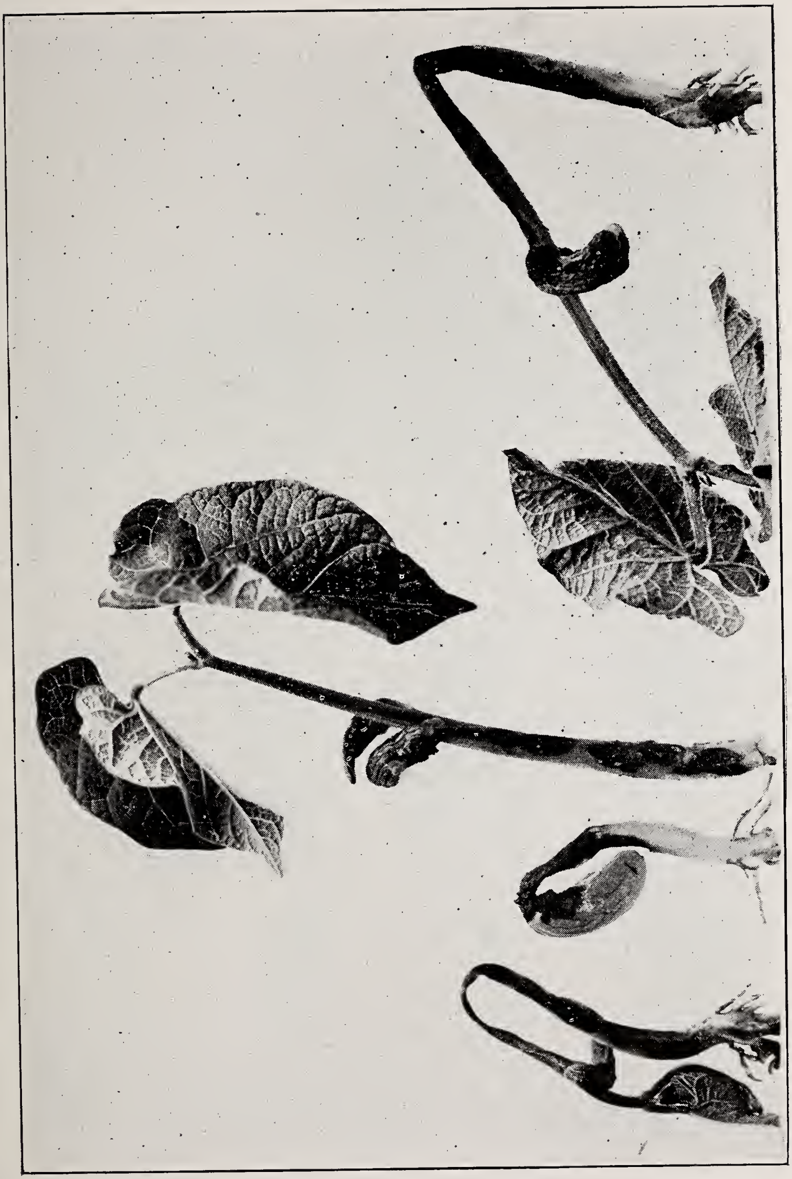


PLATE IV.

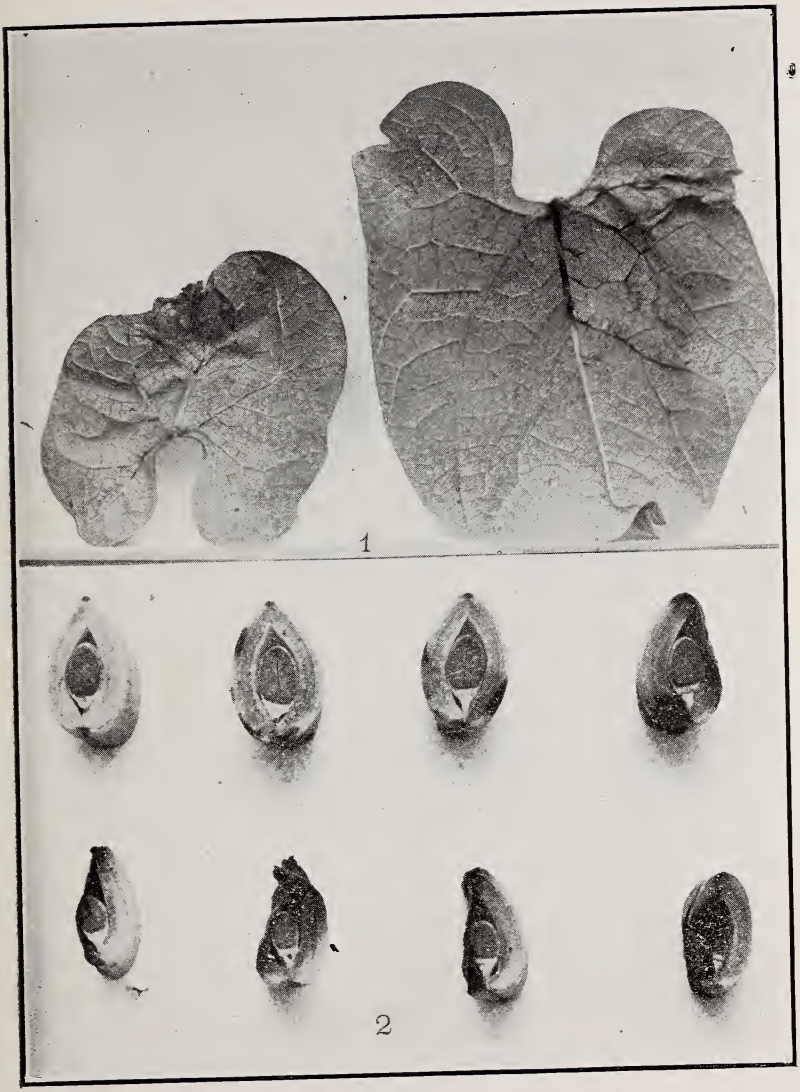


Plate V.

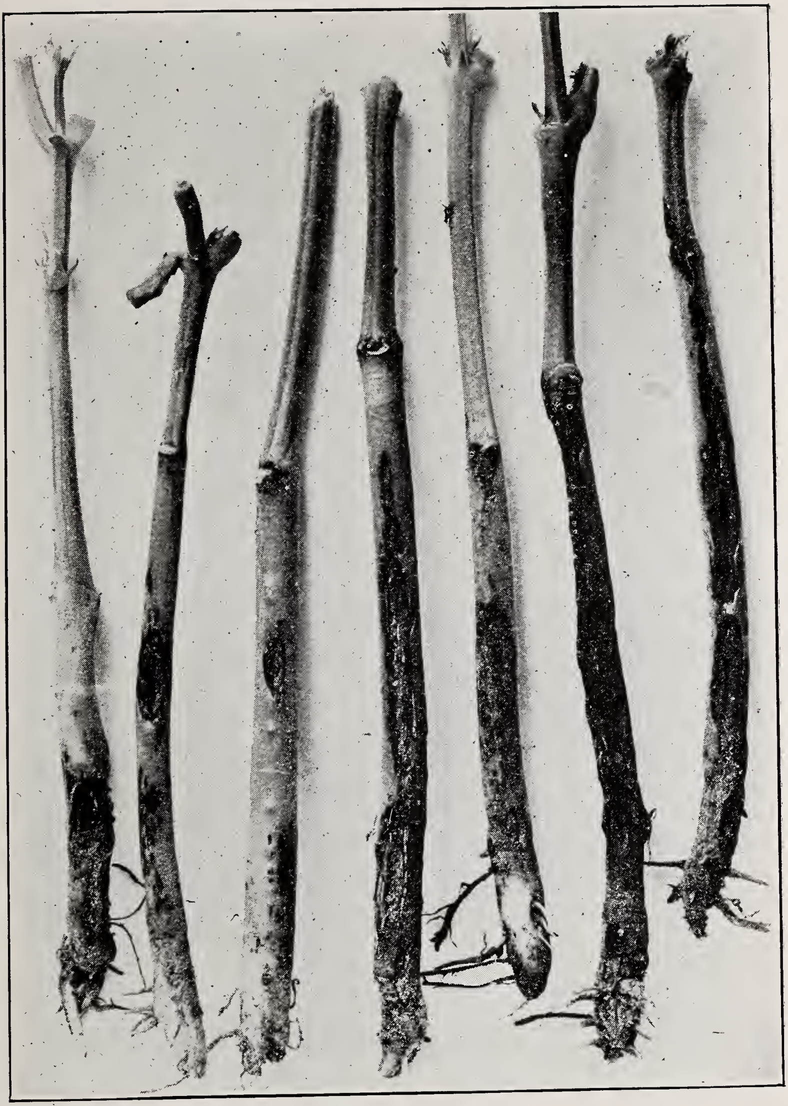
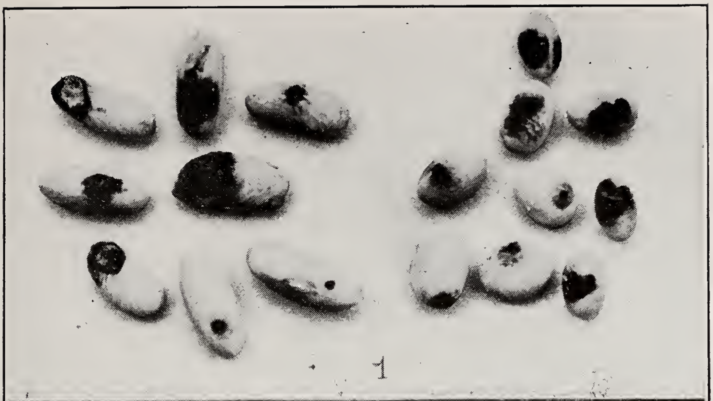
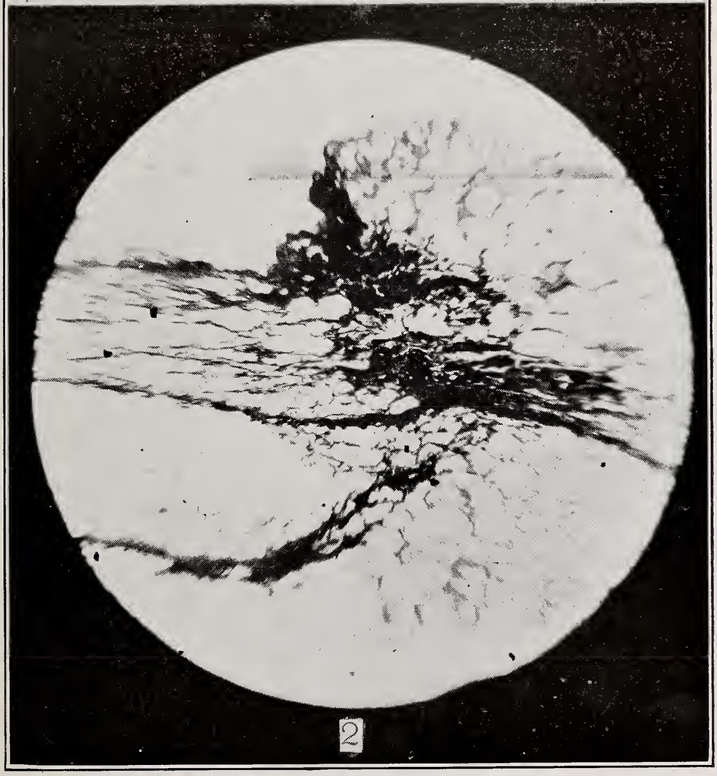


Plate VI.



1



2

Plate VII.

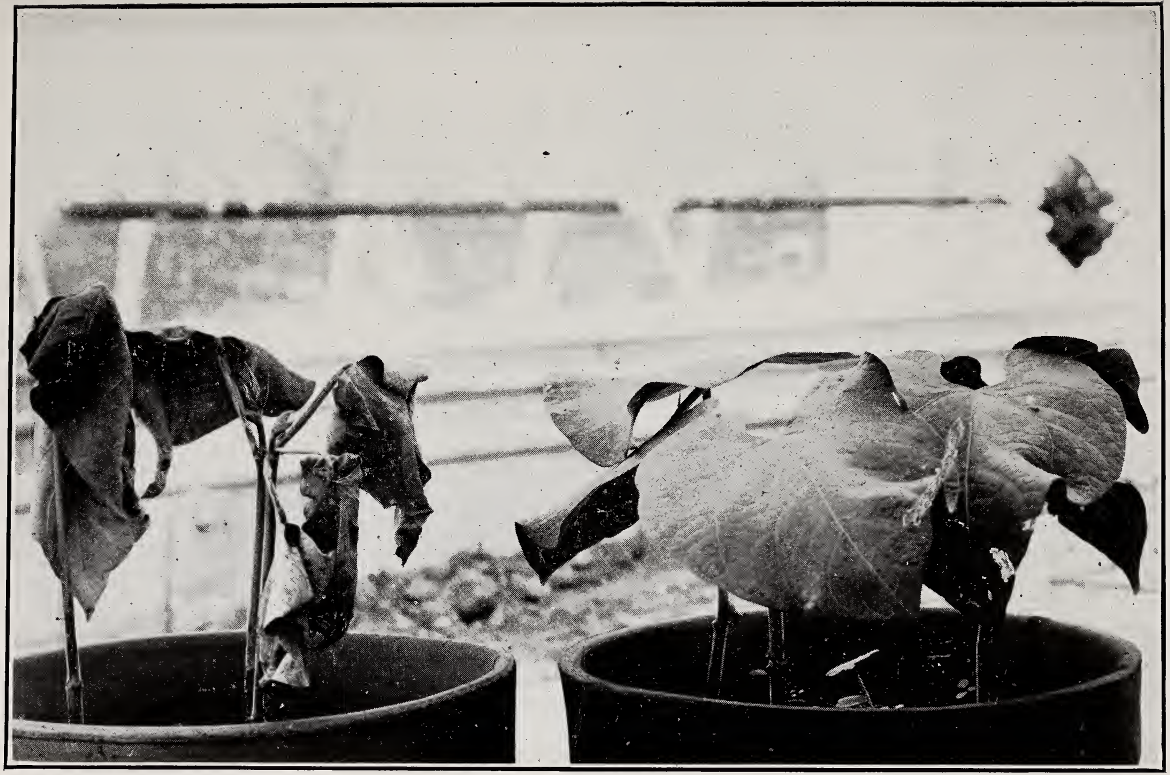


Plate VIII.

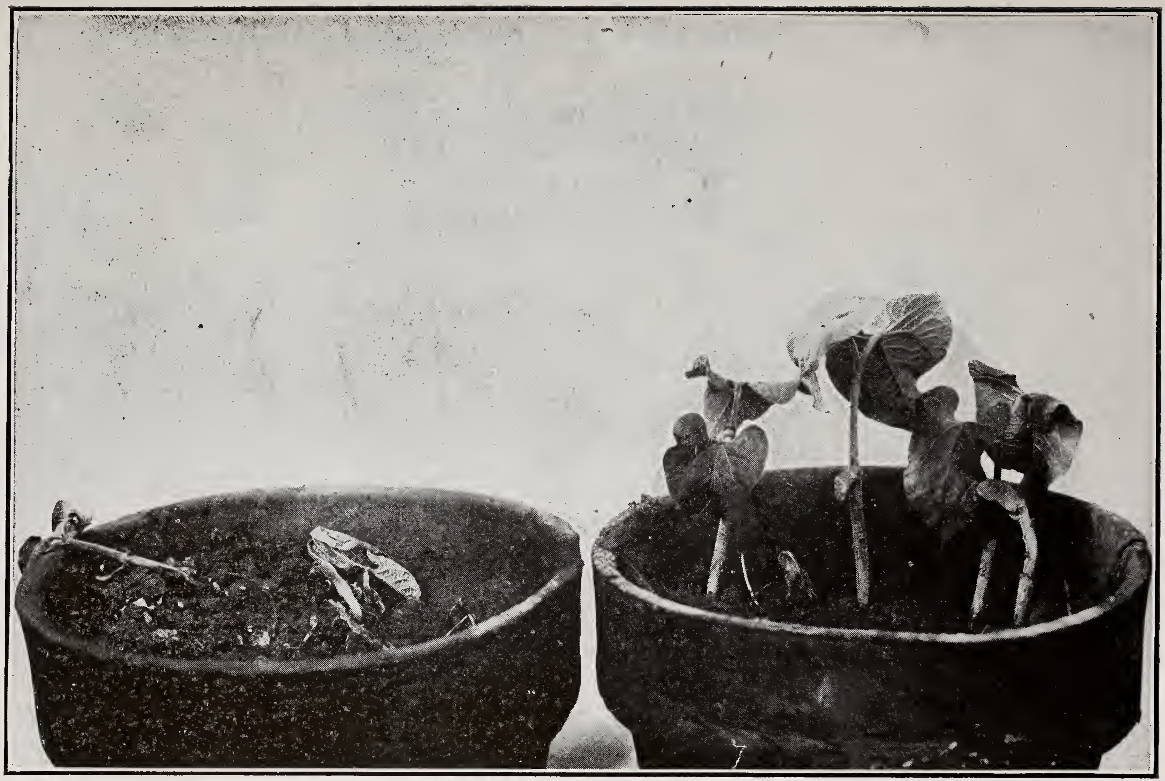


Plate IX.

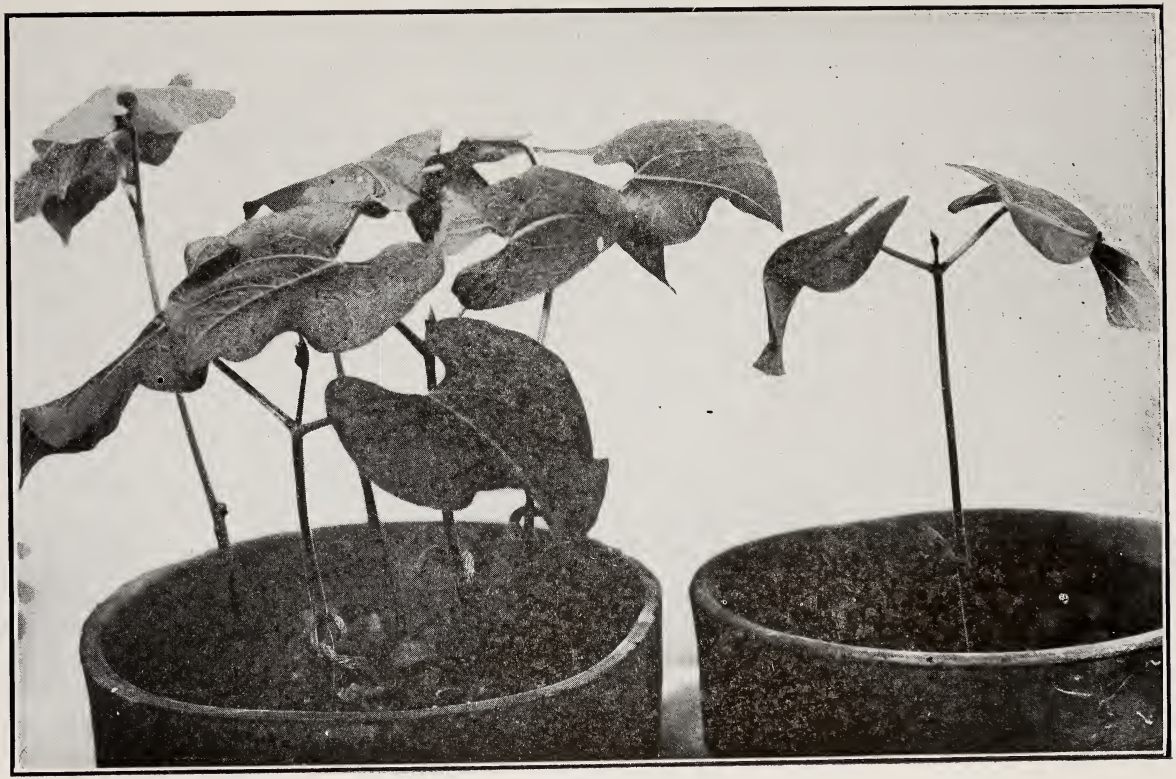


Plate X.

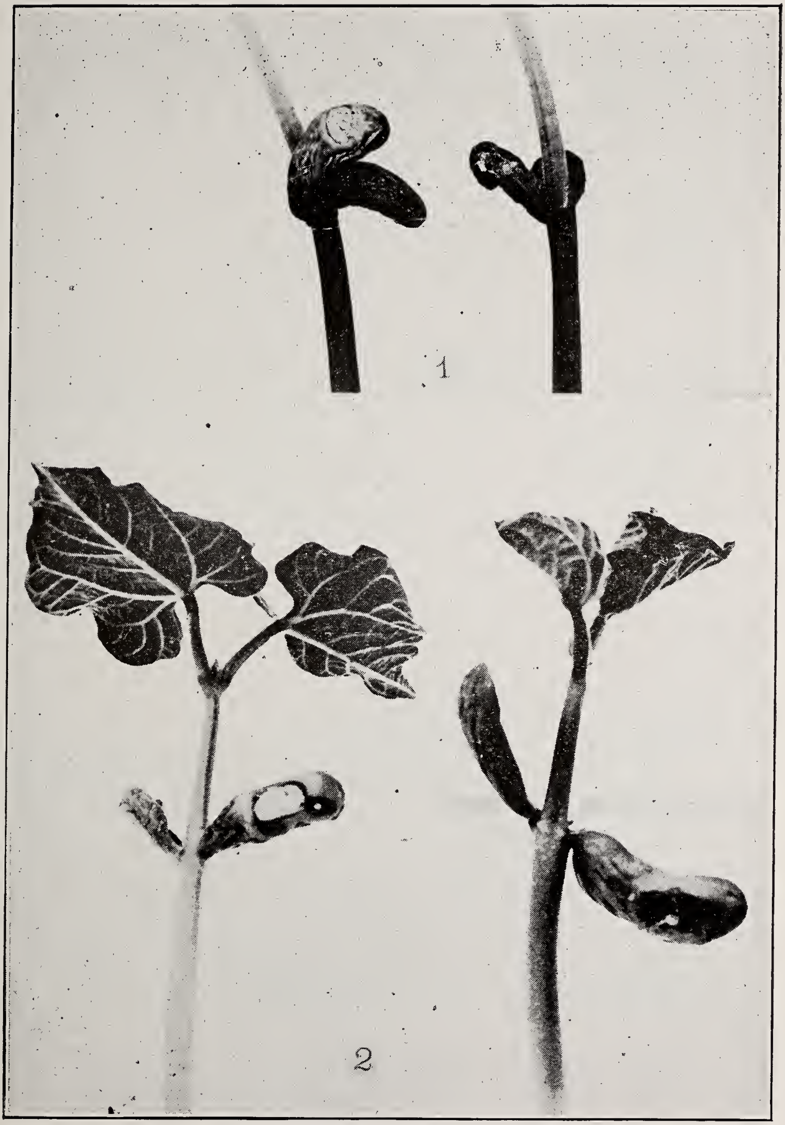


PLATE XI.

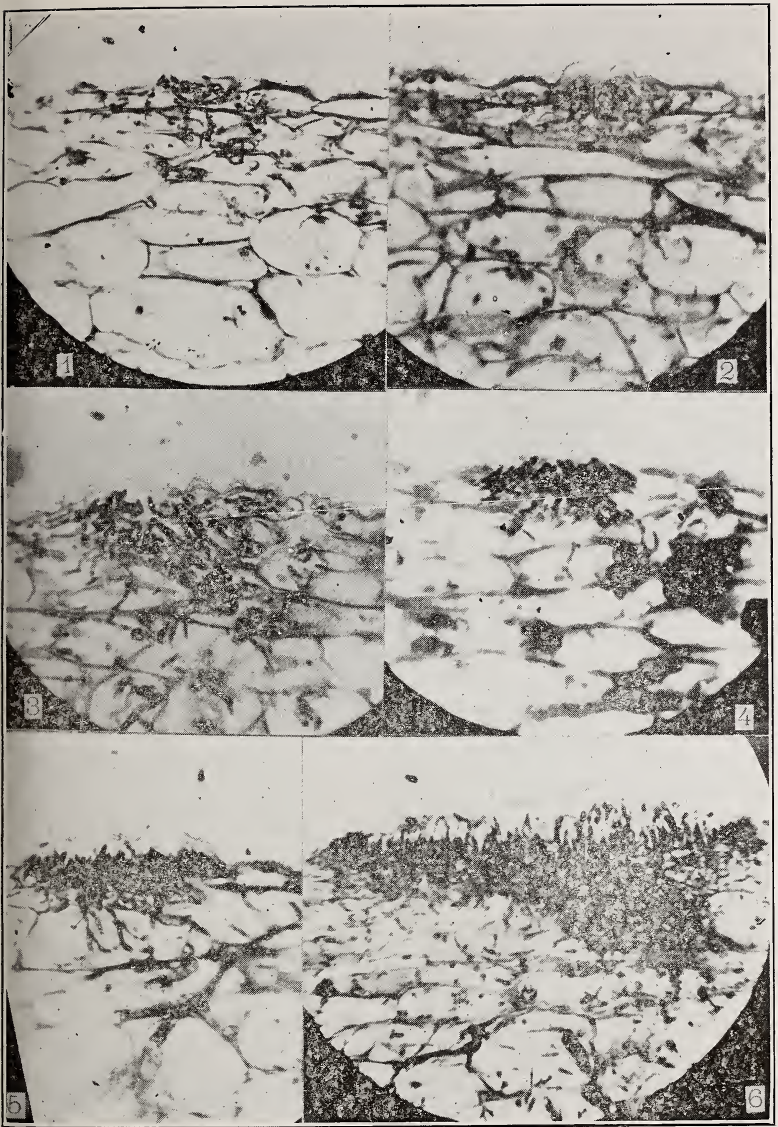


PLATE XII.

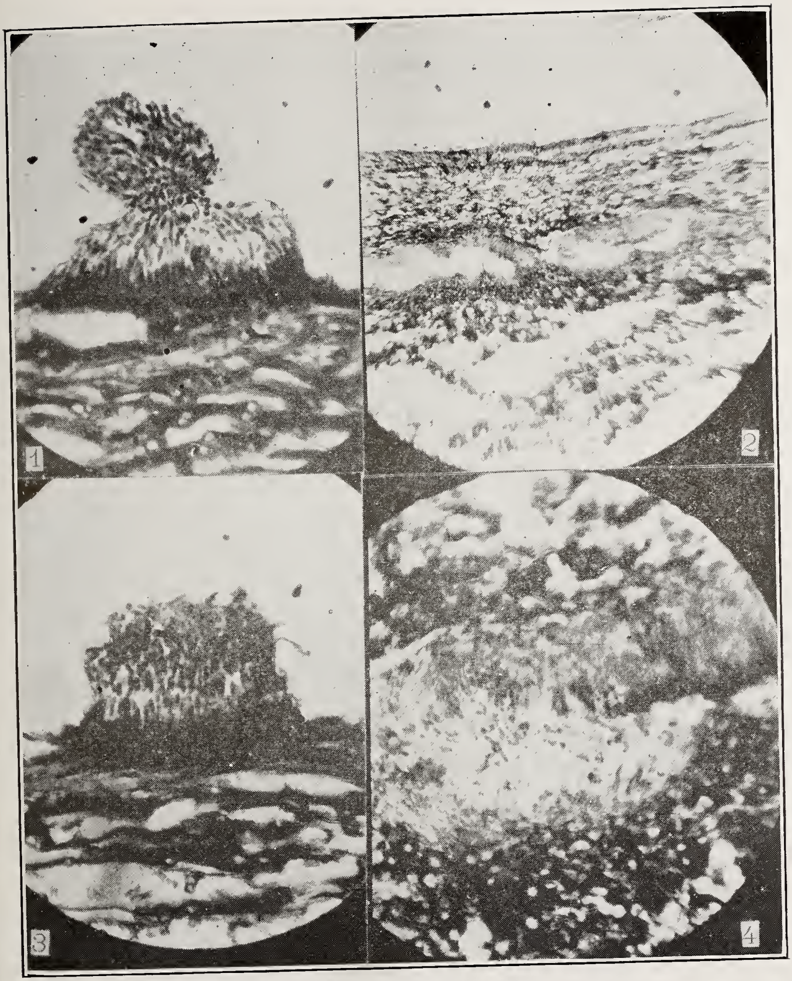


PLATE XIII.

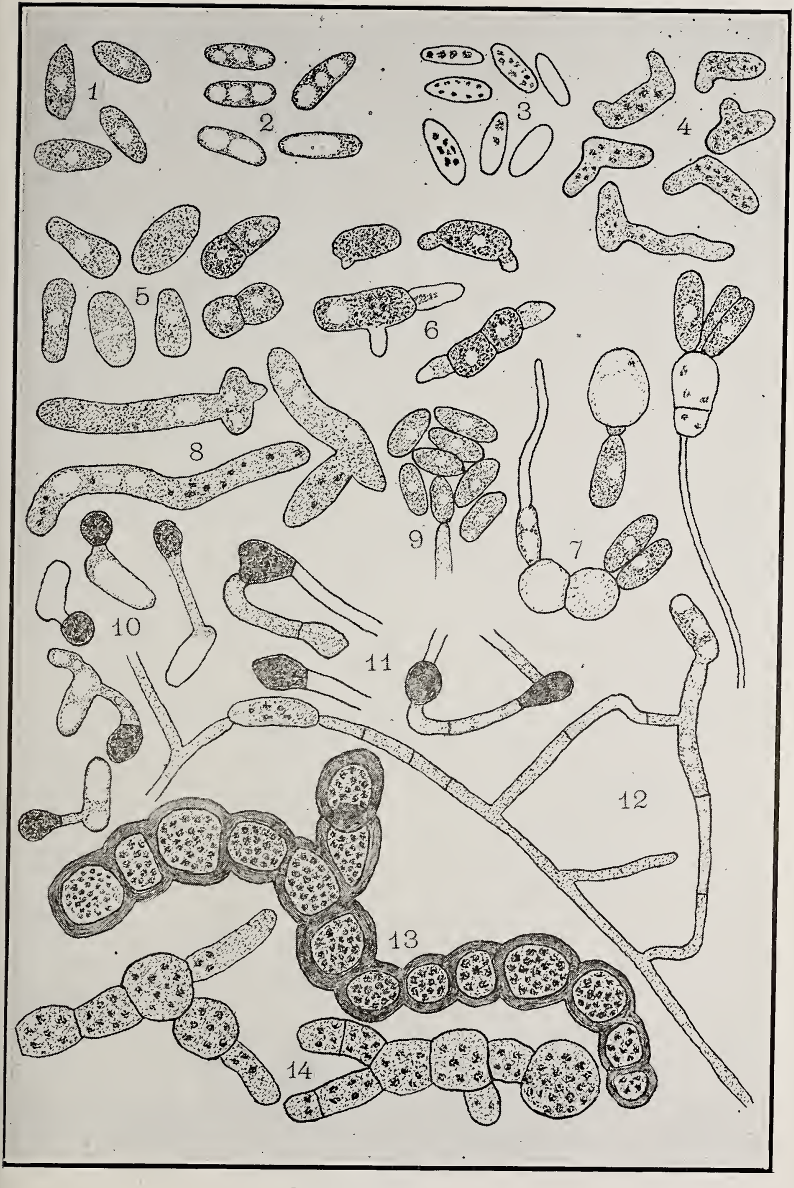


Plate XIV.

Louisiana Bulletin No. 120. July, 1910.

Agricultural Experiment Station

OF THE

Louisiana State University

and A & M. College,

BATON ROUGE.

Some Sugar Cane Diseases

BY

C. W. EDGERTON,
Plant Pathologist.

BATON ROUGE
THE NEW ADVOCATE, OFFICIAL JOURNAL
1910

Louisiana State University and A. & M. College

Louisiana State Board of Agriculture and Immigration

EX-OFFICIO.

GOVERNOR JARED Y. SANDERS, *President.*
HENRY L. FUQUA, *Vice-President of Board of Supervisors.*
CHAS. SCHULER, *Commissioner of Agriculture and Immigration.*
THOMAS D. BOYD, *President State University.*
W. R. DODSON, *Director Experiment Stations.*

MEMBERS.

R. S. Moore, St. Bernard.
Henry Gerac, Lafayette.
John T. Cole, Monroe.
John J. Henderson, Lagan.
R. E. Thompson, Wilson.
Jeff D. Marks, Crowley.

STATION STAFF.

W. R. DODSON, A. B., B. S., Director, Baton Rouge.
HAMILTON P. AGEE, B. S., Assistant Director, Audubon Park, New Orleans.
S. E. McCLENDON, B. S., Assistant Director, Calhoun.
FRIEND C. QUEREAU, B. S., Ass't Director Rice Exp'ment Station, Crowley
W. G. TAGGART, B. S., Assistant Chemist, Audubon Park, New Orleans.
WM. G. OWEN, B. S., Bacteriologist, Audubon Park, New Orleans.
J. K. McHUGH, Secretary and Stenographer, Audubon Park, New Orleans.
J. E. HALLIGAN, B. S., Chemist, Baton Rouge.
H. L. GREEN, B. S., Assistant Chemist, Baton Rouge.
A. P. KERR, B. S., Assistant Chemist, Baton Rouge.
R. BAUS, B. S., Assistant Chemist, Baton Rouge.
R. G. FULLER, B. S., Assistant Chemist, Baton Rouge.
R. G. TILLERY, B. S., Assistant Chemist, Baton Rouge.
P. H. DOHERTY, B. S., Assistant Chemist, Baton Rouge.
ROGER P. SWIRE, A. B., Treasurer, Baton Rouge.
J. B. GARRETT, B. S., Entomologist, Baton Rouge.
G. L. TIEBOUT, B. S., Horticulturist, Baton Rouge.
W. H. DALRYMPLE, M. R. C. V. S., Veterinarian, Baton Rouge.
C. W. EDGERTON, Ph. D., Plant Pathologist, Baton Rouge.
E. W. KERR, M. E., Professor Mechanical Engineering, Baton Rouge.
T. C. PAULSEN, B. S., M. D. C., Assistant Veterinarian and Bacteriologist.
J. T. TANNER, A. B., Secretary and Stenographer, Baton Rouge.
IVY WATSON, Farm Manager, Calhoun.
E. J. WATSON, Horticulturist, Calhoun.
HY. STAPLES, in charge of Dairy, Baton Rouge.
V. L. ROY, B. S., in charge of Boys' Demonstration Work

Some Sugar Cane Diseases.

By C. W. Edgerton.

The sugar planter of Louisiana has been quite fortunate up to recent years in having his crop fairly free from any serious fungus disease. To be sure, the sugar cane root rot has probably been in the state for a long time, but this has not been a menace to sugar growing and only in abnormal years has it produced serious damage. Sugar cane is a native of the tropics and for a long time after it was introduced into the United States it did not have the diseases to contend with to which it is subject in its native home. This was probably due, *First,* to the fact that the early importations of cane were free from the diseases; and *Second,* that for a long period planters used their own cane for planting. The use of home cane for seed year after year prevented the importation and spread of any of the diseases. But with this crop, as with all others, with the extension of the industry and the increased acreage, chances have arisen for the importation of many of the diseases to which the crop is subject. During the past few years much cane has been imported from the tropics for planting, and, furthermore, there has been considerable interchange of seed among the different planters. While this is necessary in order to get the best cane for our conditions, it has increased the chances for the importation and spread of fungus diseases. As a result, several of the diseases to which cane is subject in its native home have in some manner been introduced and now seem to be quite widely distributed over the sugar raising regions of the state. It would be impossible to tell at present how or when these different troubles were introduced into the state on account of the many importations of cane that have been made by different planters, but it is probable that the troubles have been introduced into different localities direct from the tropics at different times. From the present distribution, it does not seem probable that the diseases were introduced at one point in the state and from there spread to other regions.

Previous to the past year it was not known that we had any other sugar cane disease than the root rot, but now we know that we have three others—the red rot, the rind disease, and the pineapple disease. It was only after complaints of poor stands during the past season that a study of the troubles was undertaken. Of course, the spring was very dry, but this cause alone did not seem to explain all of the failures. Suspecting that some of the tropical diseases might be partly responsible for some of the losses, an attempt was made to find out the true cause or causes. Mr. H. P. Agee, of the Sugar Station, wrote to a number of planters in the different parishes of the sugar district and requested that they send in cuttings that had been planted but did not grow. A number of bundles of these canes were received and were examined carefully in order to find out the cause of their failure to germinate. The examination showed that in cane from nine different parishes eight contained the red rot; seven the rind disease; and one, the pineapple disease; while nearly all of them showed root disease to some extent. The distribution of the first three diseases in the state as far as is known at present is shown in the map in Figure 1. This does not necessarily mean that the diseases do not occur in the other parishes. It is more than likely that some of them are present at least in some of the adjoining parishes, but no specimens have been sent in from these places.

The presence of the red rot in the state had been known for some few months, but the finding of the pineapple disease and the rind disease was a surprise. While the failure to grow could not be said in every case to be due to some of the diseases, as the canes showed considerable insect work and perhaps also the effect of frost and dry weather, it seems quite certain that a considerable percent of the loss was due to the fungus diseases present.

On account of the serious nature of the new sugar cane diseases it seems best at this time to put into the hands of the planters descriptions of the troubles, their present known distribution, and notes on the injuries which they cause in the tropics, and may also cause here, so that the planters may be on the guard for them and take such measures as may seem fit for their control. The Experiment Station is always ready to answer inquiries about the diseases and will be glad to receive specimens of sugar cane troubles at any time and will be glad to diagnose the troubles and give any methods of control if known. Of course, these troubles are new with us and we need considerable experimental data before we can state the best methods of control.

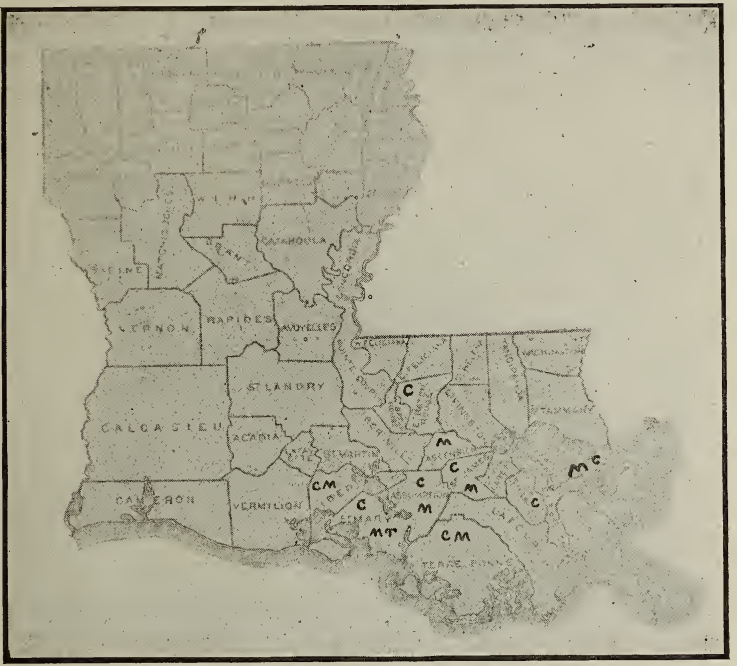


Fig. 1. Map of Louisiana showing known distribution of the red rot, rind disease, and pineapple disease in the state. C. Parishes in which the red rot, caused by *Colletotrichum falcatum,* is present. M. Parishes with rind disease, *Melanconium sacchari.* T. Parishes with pineapple disease *Thielaviopsis ethaceticus.*

THE RED ROT OF SUGAR CANE.

The red rot of sugar cane is a disease which is pretty widely distributed in the tropical sugar countries at present, it being known in Java, India, Hawaii, Madagascar, West Indies, and probably in other countries. In places, in certain years, it causes a very large loss. According to Butler (1), it is the trouble in Bengal which nearly ruins the crop in certain seasons. At present also, the trouble seems to be quite widely distributed in the southern United States. I have found it in eight parishes in Louisiana during the past year. I have also seen specimens from Cairo, Georgia, where the trouble seems to be causing considerable damage. It is also present and doing considerable damage in at least two counties of northern Florida (8). The first specimen of this disease found in the United States, as far as I know, I collected at Audubon Park, New Orleans, in February, 1908. I placed this collection in my herbarium at the time as a Volutella, and it was consequently overlooked when I wrote a short note for Science in May, 1910 (6). The next collection was from the same place in September, 1909. The specimens which I have received from southern Louisiana during the past spring have shown the disease to be quite severe in places and I think responsible for part of the poor stands during the season.

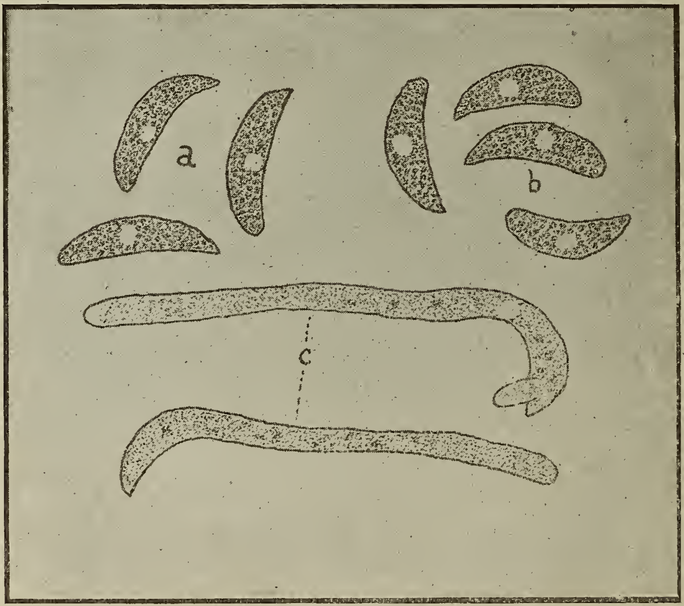


Fig. 2. *Colletotrichum falcatum.* A. Spores from material received from Georgia. B. Spores from a collection made at Audubon Park in September, 1909. C. Germination of spores in nutrient media.

THE CAUSE OF THE DISEASE.

The disease is caused by one of the small imperfect fungi, known to botanists as *Colletotrichum falcatum* Went. It was first described from Java by F. A. F. C. Went in 1893 (13).

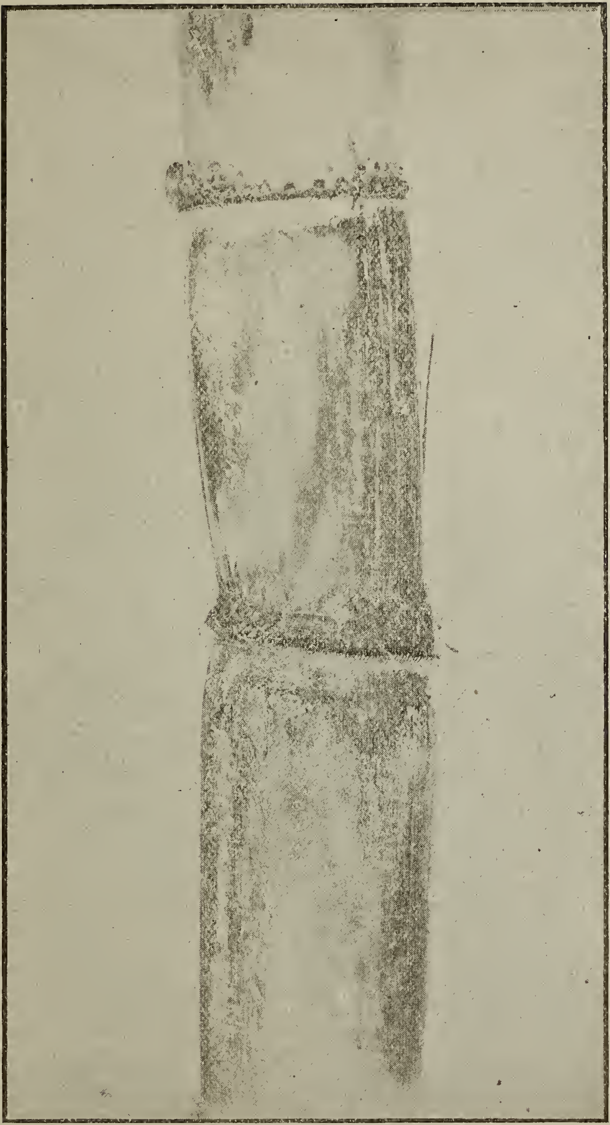


Fig. 3. Sugar cane very badly affected with red rot. Notice the discolored rind in the middle joint.

The fungus does not usually fruit profusely in nature, though occasionally the fruiting pustules may be found on dead parts of the plant or in lesions on the main stem. The fruiting pustules appear to the naked eye as very small black specks. Under the microscope, these are seen to be made up of a number of long black setae with a profuse development of spores between them. The spores (Fig. 2) are falcate or curved, and hyaline. The fungus is closely related to *Colletotrichum lineola,* which we have on Johnson Grass and other grasses in the south. It also may be closely related to *Colletotrichum cereale,* the one which causes the anthracnose of cereals in the middle west.

APPEARANCE OF THE DISEASED CANE.

The red rot disease is not easily recognized in a field of growing cane for the reason that the disease is almost entirely on the inside of the stalk. The exterior of the cane may look perfectly normal, while the interior may be badly diseased. Where the disease is very severe, according to Butler (1), who has worked on the trouble in Bengal, the leaves may turn yellow and wilt; but it is hardly probable that we will find this condition at present in Louisiana. However, in cane that has been planted or windrowed, the disease may develop so well that it will show on the outside of the cane. Many of the eyes will be dead, and there will be black dead areas extending out from the nodes (Fig. 3). There may also be somewhat sunken dead lesions on the stalks, especially on the upper joints (Fig. 4).

However, the disease is best told by splitting the stalk and examining for the characteristic red color of the tissue. The whole inside of the stalk will not be red, but the color will be more or less irregularly distributed, the red being usually in streaks or bands extending out from the nodal region (Fig. 5). There are also frequently white spots surrounded by the red tissue. These spots were present in the Georgia material and in nearly all of the collections which I have seen from Louisiana. These white spots are local centers of growth of the fungus. A microscopical examination of these spots will show the cells of the host plant to be crowded full of the mycelium of the fungus. In badly diseased stalks, there are strips also of brown tissue, generally just underneath the rind. Often also the pith of the cane will split, leaving a cavity which becomes filled with the mycelium of the fungus. Fig. 5 is quite characteristic of a badly affected cane stalk. The tissue at the node is dead and has dried out considerable, all of the color being gone. Extending out from this are the strips of red and brown tissue. One of the white spots can also be seen in the discolored tissue.

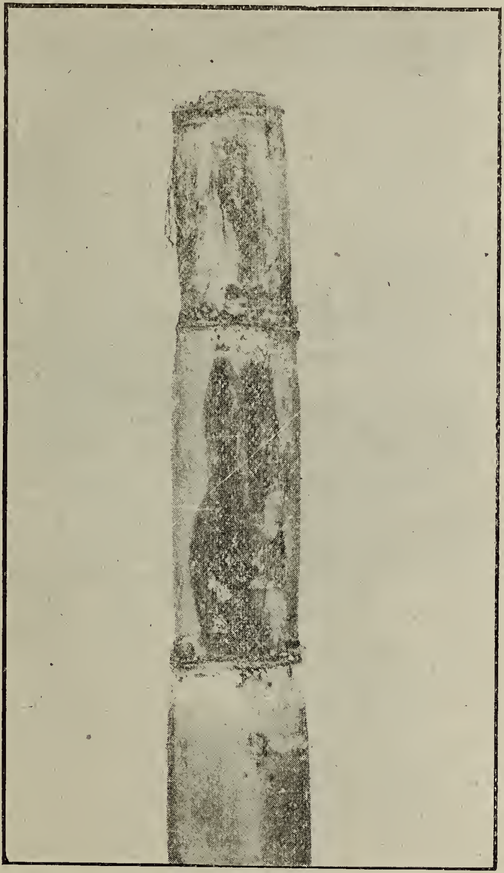


Fig. 4. Red rot of sugar cane. Shows lesions on the upper joints which contain pustules of *Colletotrichum falcatum.*

The presence of red rot in cane that has first been attacked by borers cannot be so readily told. Borer attack alone will cause a reddening of the tissue. This red, however, is usually intensified if the red rot is also present. Frequently in this cane also, the disease may be diagnosed by the presence of the white spots. But to make absolutely certain as to the presence of red rot in borer cane, cultures from the diseased tissues must be made or else the split canes be placed in a moist place and the fungus allowed to develop on the cut surface (Fig. 6).

INFECTION OF THE FUNGUS.

The fungus frequently gains entrance to the cane through borer holes, but these openings do not appear to be essential. In the Georgia material which I have seen there were no borer holes. From the appearance of this cane, the infection must have taken place at the nodes; but this matter has not been worked out as yet, and the methods of infection must be left for another publication. But in much of the Louisiana material, the infection seemed to have taken place through borer holes.

DAMAGE TO THE CANE.

The damage which is done by the red rot occurs in two forms.

First—Canes that are affected with the disease have the sugar content, especially the sucrose, very much decreased. As the value of the crop depends upon the amount of sugar in the stalks, the decrease due to the disease becomes very important. Analyses that have been made in Java, Bengal and the Hawaiian Islands show that the saccharose content is decreased by from ¼ to ⅓ by the action of the fungus. Consequently a severe attack of the disease means a big loss to the crop.

Second—The fungus grows in the stalks that are to be used for planting and kills the eyes, thus preventing germination and causing a poor stand. This seems to be the worse of the two injuries at present in Louisiana. But a poor stand means a short crop with no profits.

TREATMENT OF THE DISEASE.

The treatment of the disease should be conducted in two ways—*First,* all material in the field known to be diseased should be destroyed, and, *Second,* the cane to be used for planting should be as carefully selected as possible. As the fungus does not fruit to a very great extent, it does not spread very fast in the field. If perfectly healthy canes were planted each time, the disease would cause but little damage. However, when diseased cane is planted, the disease spreads upwards into the young

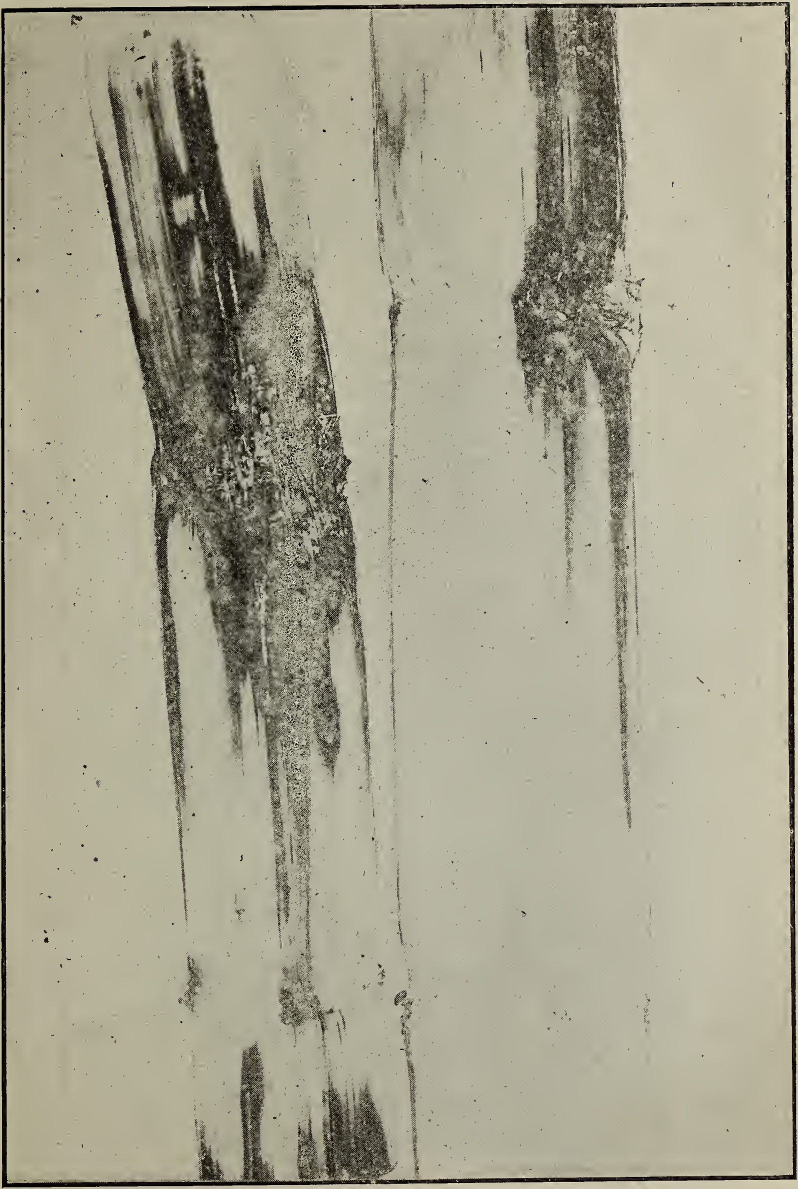


Fig. 5. Split cane showing red rot of sugar cane. Notice streaks and bands of discolored tissue passing out into the internodes from the nodes. Also notice the white spot surrounded by the discolored tissue.

stalks and the eradication of the trouble is impossible. The most desirable thing would be to select carefully all the cane to be used for planting, throwing out any that show any external signs of disease or any that are attacked by borers. This method of selection would, however, hardly be profitable on account of the large amount of time it would take to select the seed. Per-

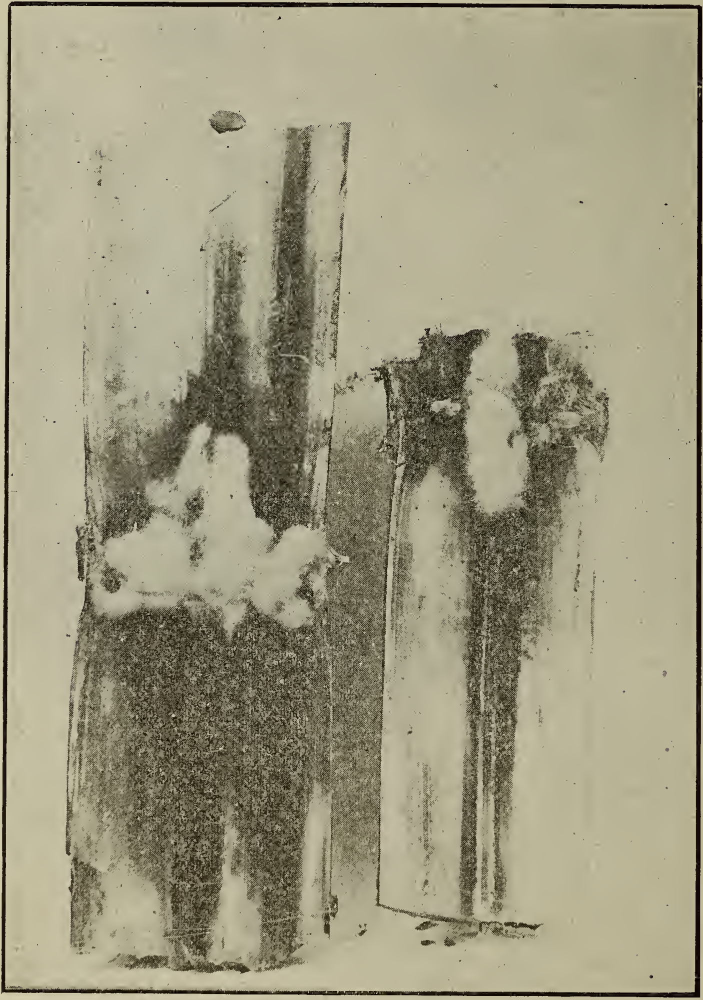


Fig. 6. Split stalk of cane affected with the red rot which has lain in a moist place for two days. The mold or mycelium in the nodal region is that of *Colletotrichum falcatum.*

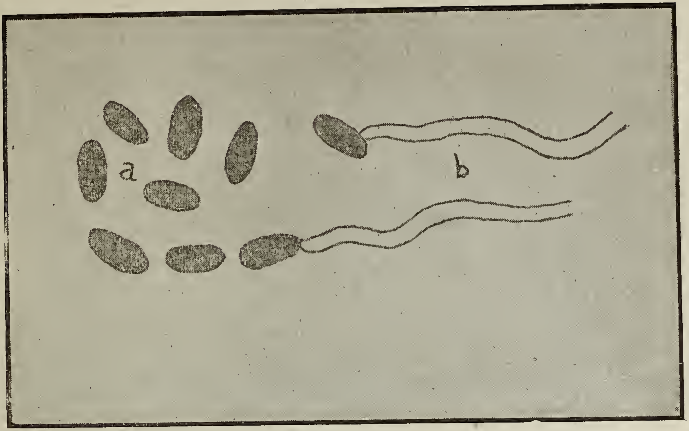


Fig. 7. *Melanconium sacchari.* A. Spores. B. Germination of spores.

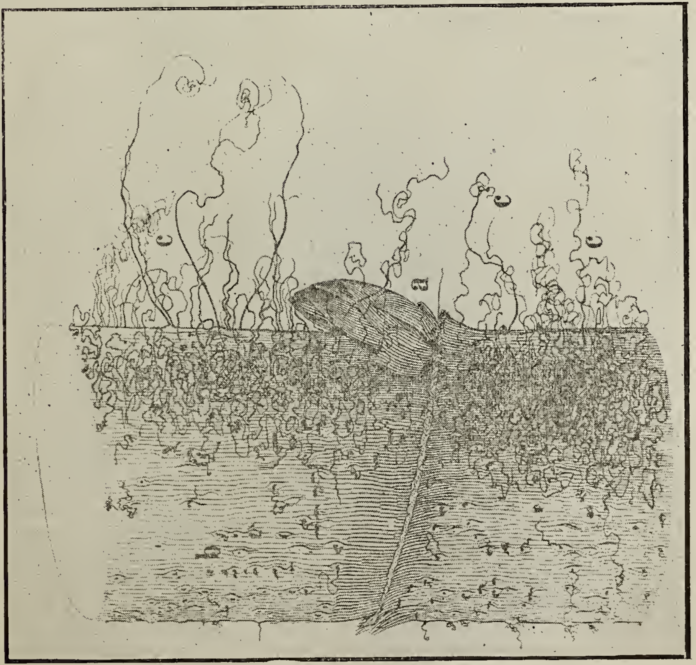


Fig. 8. Sketch of sugar cane stem affected with rind disease. Shows the long, kinky, black hairs at C, which are in reality masses of spores. (After Cobb in Bulletin No. 5 of the Experiment Station of the Hawaiian Sugar Planters' Association.)

haps the method which Mr. Roddenbery has undertaken in Georgia to free his cane from the disease is the one which will give the best results. He has very carefully selected enough cane for planting a few acres. From this he expects to get enough healthy seed for planting his crop the following year.

THE RIND DISEASE.

The only mention of this disease as occurring in the United States, as far as I can find out, is a remark made by Dr. Stubbs during a meeting of The Louisiana Sugar Planters' Association and published in the Louisiana Planter of May 21, 1910 (12). The statement is as follows:

Dr. Stubbs: "I want to say that seven or eight years ago I had a letter from Dr. Watts, in one of the West India Islands, asking if we had what he called the rind fungus, and I told him no, but at the same time I had strong suspicions that we had. In that same letter he asked me to send him some pieces of cane and I went out into the cane field and got him some pieces suitable to ship through the mail to him, and two or three weeks after that I received a letter from him saying that we had the rind fungus."

How wide the distribution of the disease in the United States is at present cannot be said. I know of its presence in seven different parishes in Louisiana, but no study has been made on the trouble in other localities.

The disease is very common in tropical sugar countries, however, and in some years causes considerable damage. For instance, in 1895, in Barbados (10), the cane crop was reduced from 50,000 to 60,000 hhd to 36,000. The loss to the sugar planters of the West Indies during a period around 1895, due to this disease, was immense. However, they have since controlled the disease more or less by using varieties which are resistant to it. While they formerly depended upon the Bourbon cane almost entirely, this has now given away to other canes, because it is very subject to the rind disease. But still, today, with the more or less resistant varieties, there is a considerable loss in the tropics due to this disease. Dr. Cobb, in the Hawaiian Islands, estimated the amount of diseased cane left in a 200-acre field after harvest (10). If this had been sound cane and had been harvested, it would have meant a ton more of sugar to the acre. A loss of this dimension is certainly worth considering.

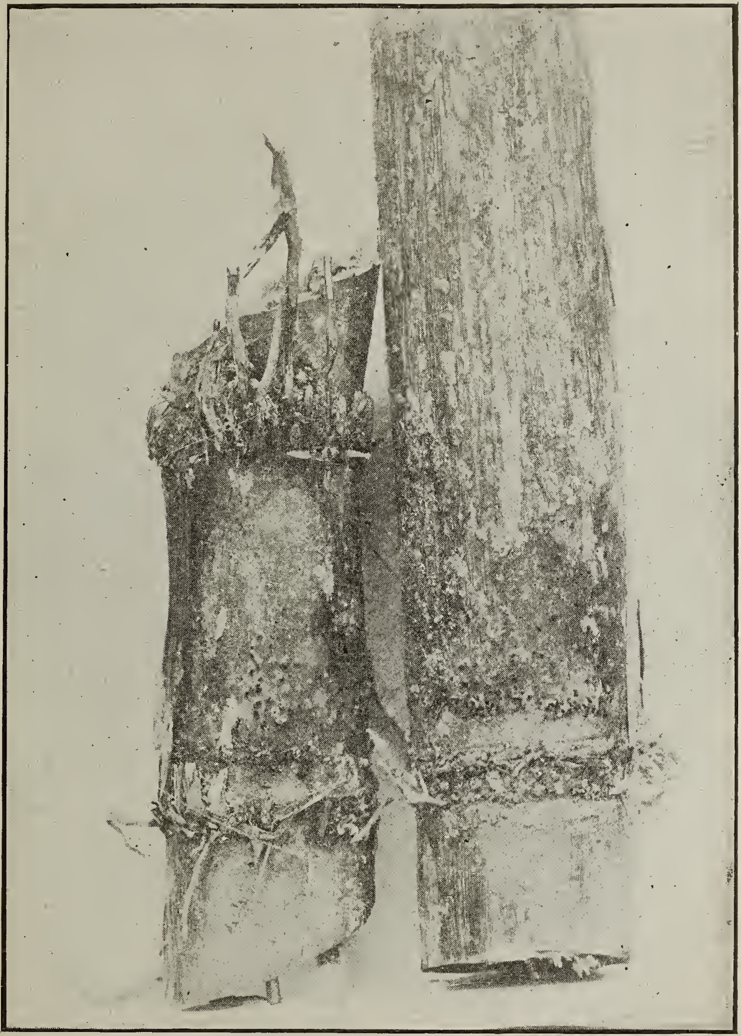


Fig. 9. Rind disease as found on Louisiana canes. Notice the black pustules near the nodes.

CAUSE OF THE DISEASE.

This disease is caused by another of the small imperfect fungi, known as *Melanconium sacchari*. The fruiting pustules of this fungus develop abundantly on the stalks, especially on those left in the field or those that have been planted or windrowed. The pustules develop underneath the epidermis of the rind tissue, being in the form of small pycnidial-like cavities. The small, linear, dark-colored spores (Fig. 7) are produced in these pustules in abundance. As the pustule becomes filled with the spores, they are forced out of a small opening at the top. As the spores are held together with a mucilaginous substance, they ooze out in the form of long black strings or hairs (Fig. 8). They have the appearance of being long black hairs, but are in reality nothing but masses of spores. However, if the surrounding air is very moist, these long black strings of spores will not be formed. The spores will be in black shining masses or inky drops at the apex of the pustule. This latter condition is a common one in Louisiana where the stalks are lying on or in the ground. This condition is illustrated in Fig. 9. But when one of these stalks is placed in an only slightly moist place the spores begin to issue in the black strings.

INFECTION OF THE DISEASE.

Infection always takes place, according to statements of those who have worked on the trouble in the tropics, through wounds of some kind. These wounds may be due to the attack of insects, as borers, etc.; to the stripping of stalks, or through the ends of stalks used for planting. As the spores develop so abundantly, they are almost sure to find their way into any injury that is present.

EFFECT OF THE DISEASE ON GROWING CANE.

As I have not seen the rind disease on growing plants in Louisiana, only having seen it in the seed cane, I will take the liberty of inserting a few paragraphs from Bulletin No. 7, of the Experimental Station of the Hawaiian Sugar Planters' Association, by L. Lewton-Brain, on the effect on the plants in the field.

''Usually the first symptom is seen in the leaves. The outer leaves begin first to dry up prematurely and turn yellow at the tips, and the drying spreads until the whole leaf is dead. Leaf after leaf may follow in this way, until the whole tip of the stick is dry and dead.''

''By the time the dying of the leaves has become a noticeable feature, we can usually find other evidence of the disease.

Examining carefully the outside of the stalk, one sees on one or two of the joints dark discolored patches, evidently abnormal. These show where the fungus is working.''

''Splitting open such a cane, we find that the tissue under the blotches is all discolored and evidently diseased. The normally whitish ground tissue is bright or dark red or reddish brown. Whenever it is possible to trace the discoloration to its starting point, this will always be found to be a wound of some sort. The wound may be a borer hole, a leaf hopper puncture or a wound made in stripping, the borer wounds being perhaps the most favorable to the fungus, especially in the older parts of the stalk.''

''In the next stage the discolored areas become somewhat sunken, lose their color and become a dirty dull yellow. The tissues underneath have been drained of their contents and killed by the fungus, hence the shrunken appearance of the stem.''

''If the disease proceeds further, we find the whole cane discolored and brown. It is very light in weight, the internodes are shrunken, and we see a number of small, black, kinky, hair-like bodies projecting from the stem. These will be seen to have been formed below the rind, which they have burst through in getting to the outer air. These kinky threads are really masses of spores of the fungus.'' (See Fig. 8.)

EFFECT ON SEED CANE.

Seed cane that is affected with the rind disease generally has an abundance of the black fruiting pustules on the surface. The interior of the cane stalk is variously colored; in material that I have seen, red, yellow, brown, and even greenish colors have been noticed. The tissue dries out rapidly so that the whole cane shrinks and becomes light in weight. The eyes of the cane are killed and there is little or no germination.

It may be that the varieties of cane grown in Louisiana are more or less resistant to the disease and the affect on the growing cane may not be noticed. If this is the case, the damage which it will do will be confined almost entirely to the cane after it is cut. This means that the damage will be to the cane that is used for seed. If the spores are on the seed when it is planted in the fall, or if they are in the piles of windrowed cane, they will attack the cane and in many cases will kill the eyes and prevent germination. Considerable cane showed this affect during the past season.

CONTROL.

From the work that has been done on this disease in the tropics during the past twenty years, a few conclusions in regard to the control of the trouble may be drawn.

First: The Use of Resistant Varieties. Some varieties of cane are very susceptible to the disease, while others are highly resistant. The Bourbon cane, for instance, was so susceptible that for a period the cane crop in Cuba was very much reduced. Since that time, however, more resistant varieties have come into use in that country.

It is impossible to tell, at present, how resistant our varieties are on account of the lack of any data on the point.

Second: The Cleaning Up of the Fields. The disease develops very abundantly on old cane material that has been left in the field, and it is not an exaggeration to say that there may be millions of spores developed on each stalk. If there is a considerable amount of these old stalks and other cane trash left on the ground the spores will become so abundant in the field that every planted cane will be exposed to infection. If, however, the fields are thoroughly cleaned up in the fall a large amount of this infectious material will be destroyed. On some plantations in countries where the diseases are particularly severe the owners make a practice of using Saturday afternoons for destroying all the old worthless and diseased stalks by running them through the mill. Of course, this would probably not be profitable in Louisiana at present, but all means in reason should be taken to get rid of the old diseased material in the fields.

Third: The Treatment of the Seed. This point will be taken up after the discussion of the next disease, as it applies equally well with the two troubles.

THE PINEAPPLE DISEASE.

The pineapple disease is perhaps the most serious of all the sugar cane diseases. The trouble is widely distributed in all the sugar-growing countries of the tropics and in all cases does a large amount of damage. Previous to this, however, we have not had the disease to contend with in Louisiana, as it has now just appeared in the state. It is not known to occur in any other state, and is only known to be presented in one parish in Louisiana. Some seed cane sent in from St. Mary parish in April contained a small amount of this disease. However, from the limited amount of the disease found in the cane received, it is probable that it has not become firmly established even in that parish as yet. But there is a strong likelihood of it developing rapidly and spreading to other parts of the state. The presence of this disease in the state is indeed a very serious matter. Of course, there is a small chance that the fungus will not be able to stand our winters and therefore will be of little economic importance, but such good luck as this can hardly be hoped for. The wisest course for the Louisiana sugar planter is to be prepared for the worst and be prepared to take such measures as are possible for the control of the trouble and for preventing its spread.

THE CAUSE OF THE DISEASE.

The disease is caused by another one of the small imperfect fungi, known to botanists as *Thielaviopsis ethaceticus.* The fungus is an extremely rapid growing one and forms spores in abundance. Two kinds of spores are produced. There are first some small linear to oval, hyaline to brown ones (Fig. 10, a-d), which are produced inside the hyphal threads and are pushed out in chains. These are called the micro-conidia. These develop very abundantly on cut surfaces of affected sugar cane stalks, and perhaps also to some extent imbedded in the tissue of the host plant. These spores are blown around to other cane by the wind or are carried by insects. They germinate at the first opportunity and if they are in contact with another stalk produce the disease in it.

Then the fungus produces some larger, thick-walled. dark-colored spores, called the macro-conidia (Fig. 10, e-f). These are borne in chains at the end of the conidiophores, but they are not borne within the fungus threads, as are the micro-conidia. These serve as resting spores. According to Cobb, they do not germinate immediately, but seem to need a period of rest. If a diseased cane is split, in the matter of a day or so, the cut surface will become black in color, due to the abundance of these spores.

INFECTION OF THE CANE.

This disease gains entrance to the stalks of cane entirely through wounds in the rind. These wounds may be due to the injury of insects or they may be the cut ends of the stalks. After the fungus has once gained entrance to the stalk it spreads very rapidly, decomposing the cane tissue and killing the eyes.

APPEARANCE OF THE DISEASED STALKS.

A stalk affected with this disease does not usually show on the outside. The exterior of the rind may be perfectly sound in appearance, while the interior may be badly decomposed. On splitting the stalk, however, the disease can usually be told (Fig. 11). If the disease has progressed to any extent, the center of the stalk will be more or less decomposed. The sugar-containing cells have been disintegrated, and the fibro-vascular bundles of the central region will be seen to be more or less free. This central cylinder, or "pipe," as it is called, is generally nearly black in color. If the disease has not progressed far, however, this black color may not be present, but it will develop in a few hours if the split stalk is left in a moist place, as this black color is due to the presence of the macro-conidia.

Then, if the whole stalk is not as yet affected, there will generally be a sharp boundary between the diseased and the healthy joints. The fungus grows very rapidly through the internodes, but is halted for a time at each node. Figure 11 shows this quite well, the upper nodes being badly affected, while the lower one is still sound. Of course, the stopping of the fungus by the node is only for a time. It soon is able to pass this point and then rapidly grows through the next internode.

Another characteristic point in regard to this disease is the odor given off by the affected stalks. The odor is described as similar to that of ripe pineapples, and on this account it has received the name of "the pineapple disease." The disease does also affect pineapples in the tropics, but it did not get its name

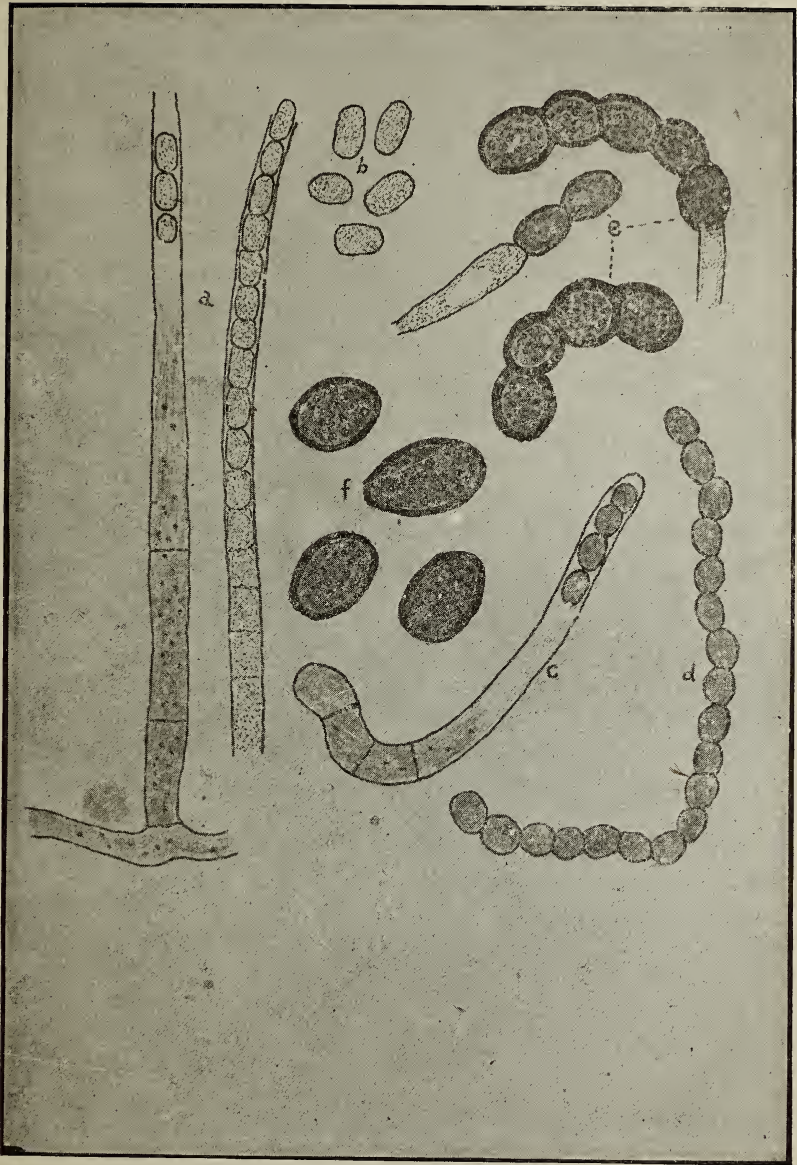


Fig. 10. *Thielaviopsis ethaceticus.* A. Conidiophores bearing the hyaline micro-conidia, as found in pure cultures. B. Some of the hyaline micro-conidia. C. Conidiophores bearing the brown micro-conidia, as found in a diseased stalk. D. A long chain of the brown micro-conidia. E. Macro-conidia, as produced in pure culture. F. Macro-conidia, as found in a diseased stalk.

from this. The odor is supposed to be due to acetic ether, the same as in the pineapple. However, in all the canes which I have had, the odor could be readily told from that of pineapples. The odor is an ethereal one, sometimes quite strong and penetrating, and is, in fact, very pleasant to the smell.

CONTROL.

As the fungus grows in the soil, and is more or less at home there, it is a disease quite difficult to control. In tropical countries, where the fungus is everywhere present in the soil, the only thing that can be done is to treat the seed cane with some fungicide as Bordeaux Mixture, thus prohibiting the entrance of the fungus into the stalk. But for the Louisiana planter there are some other points which should be observed. The disease, at present, only has a very limited distribution in Louisiana, and in sections where it is present it has not completely infected the soil. Because the disease is not yet doing a great deal of damage is no reason why the planter should be unconcerned over it. A planter that does not have the disease as yet should be on guard for it and take all measures possible to keep it off his plantation and also off the surrounding plantations. It is easier to keep a disease out of a region than to get rid of it after it has once obtained a foothold. We should take into consideration not only the methods for the control of the disease in fields where it is already present, but also the means of preventing its spread to regions not yet infected.

The disease may be spread into new regions in a number of ways, a few of which are as follows:

1. *By the Exchange of Cane for Planting.* There has been considerable exchange of cane by planters during the last few years. This has especially been the case since the introduction of some of the newer and better varieties as D-74. The planters have been desirous of trying the new varieties and have obtained them wherever they could. In the future, the planter should be on his guard in regard to this. He should not obtain cane from other regions unless he is positive that the pineapple disease is not present in the region from which he is obtaining it. If he gets some seed cane from some planter that has the pineapple disease, he can expect nothing else than to plant the pineapple disease on his plantation.

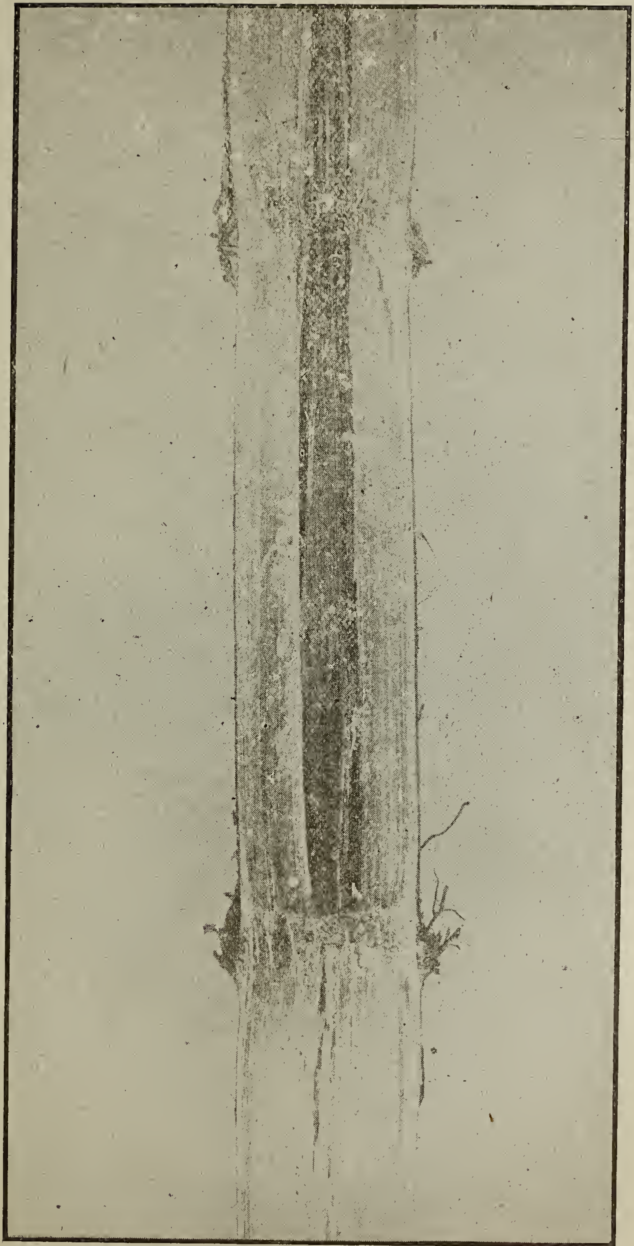


Fig. 11. Split stalk of cane affected with the pineapple disease. The two upper joints are affected, while the lowest joint is still sound. Shows the black "pipe" through the center of the stalk.

2. *By the Shipping of Cane to Mills.* The disease may be carried to the mills in the cane and obtain a foothold in the region adjacent to the mills. If the owner of a mill is in a region where there is no pineapple disease, it would probably be better for him to refuse to take cane that comes from an infected region. Cane grown in an infected region should be ground as near to the place where it was grown as possible.

3. *By Means of Insects.* Insects, doubtless, are important in spreading and increasing the severity of the disease. All means possible should be taken to prevent the insect work. Active measures should be taken against the borers and the *poo-a-pouche.* Furthermore, all sugar cane material in the field should be cleaned up as far as possible, thus reducing the amount of infectious material which a large number of insects might work on. The insects working on this material are liable to carry the spores of the fungi to other plantations and in that way spread the disease. The cleaning up of the fields has already been touched on in the discussion of the rind disease.

TREATMENT OF CANE CUTTINGS.

After the soil is thoroughly infected with the disease, perhaps the only thing that will insure a good stand of cane is the treatment of the cane with some fungicide. Both the pineapple disease and the rind disease enter the seed through wounds and the cut ends of the stalks. The rind is impervious to the attack of these fungi. The object desired in treating cane cuttings is to thoroughly cover them with some compound that is poisonous to the fungi causing the diseases. For instance, as has been shown by Cobb (3), if the cut ends of the stalks are dipped in tar and carbolic acid and then planted, the fungi not being able to grow where these substances are present, will not be able to get to the interior of the stalk. Of course, the dipping of the ends is not practicable on a large scale on account of the expense involved. In order to treat the cane on a large scale and to treat it rapidly, we must have some solution in which the whole stalk can be placed, one which will not kill the eyes of the cane but one which will prevent the attack of the fungi. The only solution which we have at present which approaches this requirement is Bordeaux Mixture. This is a copper-lime compound which is very poisonous to fungi and will not penetrate the eyes of the cane so as to hurt their germination. The treatment of sugar cane cuttings with this solution is not only practicable but is highly profitable in tropical sugar countries. Of course, special machinery and special tanks are used so that a large amount of seed can be run through the solution in a short time. Whether the treatment of the seed would be profitable to the Louisiana planter in normal years is a question, but I am convinced that it would have been profitable during the past

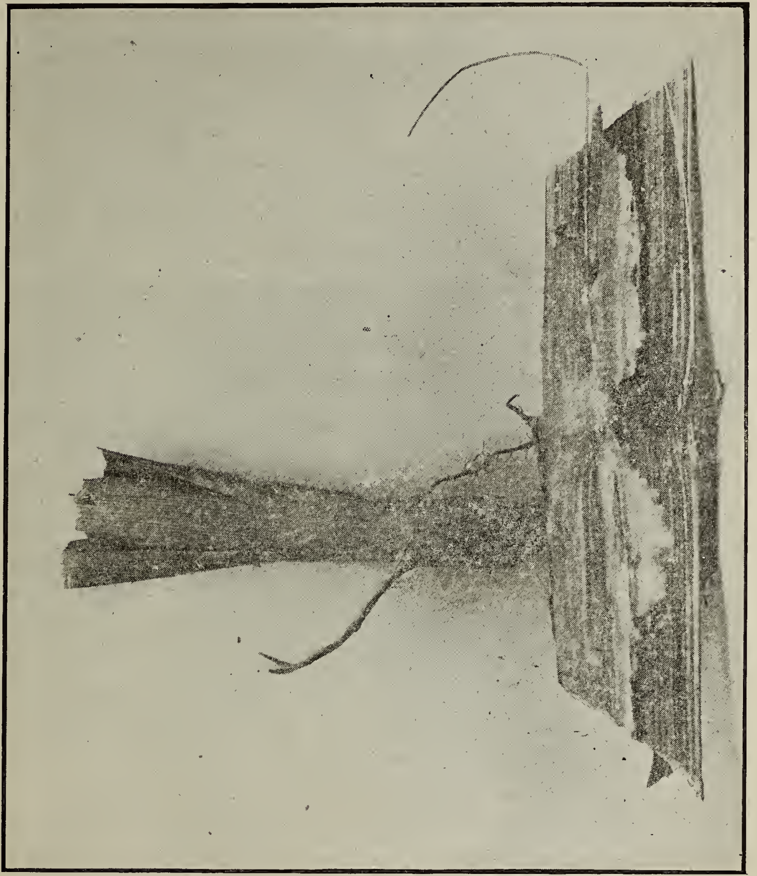


Fig. 12. Root rot of sugar cane in the seed and on the young plant. The specimen was allowed to lie in a moist place for twenty-four hours, thus bringing out the mycelium so that it shows well in the photograph. The mycelium is in the old seed stalk and also on the young plant which it has killed.

dry season. And if the pineapple disease spreads over the state and does as much damage as it does in the tropics, the treatment of the seed will not only be profitable but it may become a necessity.

THE ROOT ROT DISEASE.

The root rot disease has been well treated in Bulletin 100 of the Louisiana station and only a few points need be mentioned here. The disease is caused by one of the higher fungi, one of the mushrooms, known to botanists as *Marasmius plicatus*. This disease attacks both the cuttings and the growing cane. On the growing cane, it kills the roots and grows in between the lower leaf sheaths. The leaf sheaths are not shed as is the case with healthy cane, but remain glued together around the stalk. If some of these are pulled apart, a network of white mycelium will be seen between them. In August, or perhaps during other seasons, if the weather conditions are suitable, the little mushrooms, the fruiting part of the fungus, develop on these leaf sheaths.

On the cane which is used for seed, this disease will also develop. I have seen it to some extent in nearly every batch of cane which has been sent me this year. The mycelium enters the cut ends of the stalks and grows through them. The disease is readily told by the presence of the white strands of mycelium which may be on or in the stalks. Sometimes the eye is killed before germination, and sometimes the young plant is killed after germination. Figure 12 illustrates a cutting that had germinated but the young plant had been killed by the fungus. The stalk was split and allowed to lie in a moist place for twenty-four hours. This brought out the mycelium so that it would show better in the photograph. This shows the mycelium within the stalk and also on the young plant.

This disease is widely distributed in the state and probably has been for a long time. In some places it does considerable damage, but in normal years the loss has not been large. This year it has caused considerable loss both in the plant cane and in the stubble. The dry weather has put the cane in a more or less unhealthy condition and the cane has been very susceptible to the disease. (For further discussion of this disease see Louisiana Bulletin No. 100.)

OTHER CANE ROTS.

While the fungi causing the four diseases previously discussed were the most frequent and the most prominent in the cane cuttings that were received, there were some other organisms present which undoubtedly rotted some of the cane and should be studied further. As it is the intention of the station to continue the study of the sugar cane diseases, the study of these will be taken up as time permits.

SUMMARY.

During the past season the sugar planters of Louisiana have had considerable trouble in obtaining good stands of cane. The investigations of the Experiment Station have shown the trouble to be due primarily to several fungus diseases.

These diseases have been much more severe this year than in previous years on account of the very dry spring. The dry weather reduced the vitality of the cane and made it more susceptible to the diseases.

The diseases present in the state are the red rot, the rind disease, the pineapple disease, and the root rot.

The red rot, rind disease, and root rot are widely distributed over the state, but the pineapple disease is at present only known in one parish.

LITERATURE.

1. Butler, E. J., Fungus diseases of the sugar cane in Bengal. Memoirs of the Dep't of Agr. in India. Bot. Series, Vol. 1, No. 3. Pusa. 1906.

2. Cobb, N. A., The inspection and disinfection of cane cuttings. Hawaiian Sug. Planters' Assoc. Exp. Sta. Bull. 1. 1905.

3. ——— Fungus maladies of the sugar cane. H. S. P. A. Exp. Sta. Bull. 5. 1906.

4. ——— Fungus maladies of the sugar cane. H. S. P. A. Exp. Sta. Bull. 6. 1909.

5. ——— Notes on some diseases of the pineapple. Hawaiian Forester and Agriculturist 4: 123-144. 1907.

6. Edgerton, C. W., *Colletotrichum falcatum* in the United States. Science n. s. 31, 717-718. 1910.

7. ——— The diseases of sugar cane. The Louisiana Planter 44: 484-485. 1910. Also, The Modern Sugar Planter 1, No. 4: 9-10. 1910.

8. Fawcett, H. S., The red rot of sugar cane. Fla. Exp. Sta. Press Bull. 150. 1910.

9. Fulton, H. R., The root disease of sugar cane. La. Exp. Sta. Bull. 100. 1908.

10. Lewton-Brain, L., Rind disease of the sugar cane. H. S. P. A. Exp. Sta. Bull. 7. 1907.

11. ——— Red rot of the sugar cane stem. H. S. P. A. Exp. Sta. Bull. 8. 1908.

12. Stubbs, W. C., (Note on rind disease) Louisiana Planter 44. May 21, 1910.

13. Went, F. A. F. C., Het Root-Snot. Mededeelingen van het Proofstation, West Java. Kagok-Tegal. 1893.

Louisiana Bulletin No. 121. July 1910.

Agricultural Experiment Station

OF THE

Louisiana State University

and A. & M. College

BATON ROUGE

A PRELIMINARY REPORT ON

The Sugar-Cane Mealy-Bug

BY

J. B. GARRETT

BATON ROUGE
THE NEW ADVOCATE, OFFICIAL JOURNAL
1910

Louisiana State University and A. & M. College

Louisiana State Board of Agriculture and Immigration

EX-OFFICIO.

GOVERNOR JARED Y. SANDERS, *President.*
HENRY L. FUQUA, *Vice-President of Board of Supervisors.*
CHAS. SCHULER, *Commissioner of Agriculture and Immigration.*
THOMAS D. BOYD, *President State University.*
W. R. DODSON, *Director Experiment Stations.*

MEMBERS.

R. S. Moore, St. Bernard.
Henry Gerac, Lafayette.
John T. Cole, Monroe.
John J. Henderson, Lagan.
R. E. Thompson, Wilson.
Jeff D. Marks, Crowley.

STATION STAFF.

W. R. DODSON, A. B., B. S., Director, Baton Rouge.
HAMILTON P. AGEE, B. S., Assistant Director, Audubon Park, New Orleans.
S. E. McCLENDON, B. S., Assistant Director, Calhoun.
FRIEND C. QUEREAU, B. S., Ass't Director Rice Exp'ment Station, Crowley
W. G. TAGGART, B. S., Assistant Chemist, Audubon Park, New Orleans.
WM. G. OWEN, B. S., Bacteriologist, Audubon Park, New Orleans.
J. K. McHUGH, Secretary and Stenographer, Audubon Park, New Orleans.
J. E. HALLIGAN, B. S., Chemist, Baton Rouge.
H. L. GREEN, B. S., Assistant Chemist, Baton Rouge.
A. P. KERR, B. S., Assistant Chemist, Baton Rouge.
R. BAUS, B. S., Assistant Chemist, Baton Rouge.
R. G. FULLER, B. S., Assistant Chemist, Baton Rouge.
R. G. TILLERY, B. S., Assistant Chemist, Baton Rouge.
P. H. DOHERTY, B. S., Assistant Chemist, Baton Rouge.
ROGER P. SWIRE, A. B., Treasurer, Baton Rouge.
J. B. GARRETT, B. S., Entomologist, Baton Rouge.
G. L. TIEBOUT, B. S., Horticulturist, Baton Rouge.
W. H. DALRYMPLE, M. R. C. V. S., Veterinarian, Baton Rouge.
C. W. EDGERTON, Ph. D., Plant Pathologist, Baton Rouge.
E. W. KERR, M. E., Professor Mechanical Engineering, Baton Rouge.
T. C. PAULSEN, B. S., M. D. C., Assistant Veterinarian and Bacteriologist.
J. T. TANNER, A. B., Secretary and Stenographer, Baton Rouge.
IVY WATSON, Farm Manager, Calhoun.
E. J. WATSON, Horticulturist, Calhoun.
HY. STAPLES, in charge of Dairy, Baton Rouge.
V. L. ROY, B. S., in charge of Boys' Demonstration Work.

The Sugar-Cane Mealy-Bug.

(*Pseudococcus calceolariae* Mask[1].)

By J. B. Garrett.

The sugar cane mealy-bug is restricted, fortunately, in its distribution over the State of Louisiana. In the districts in which it occurs the species is known to the planters as pou-â-pouche.[2]

For the information of planters not acquainted with the pest, it can be described as a white, mealy-like, cottony mass of small stationary insects (see fig. 5) to be found about the roots, around the crown and around the nodes or joints of the sugar-cane plant. The mealy-like secretion, giving the common name mealy-bug, is conspicuous and not the individual insects.

Upon examination the mass is found to consist of many wingless insects, pinkish in color, and about 1-5 of an inch in length. These are the female mealy-bugs and the cottony secretion is the repository for the eggs, which, upon still closer examination may be recognized imbedded in the mass. The eggs are very small with rounded ends, yellowish when first deposited, and changing to pink as the time for hatching approaches. The adult male mealy-bug is a winged insect, is not stationary, and is not usually recognized by the planter.

Just how long the sugar-cane mealy-bug has been in Louisiana and from whence it came is problematical. Information received from some of the oldest cane planters in Southern Louisiana indicates that the insect was imported on seed cane about twenty-five years ago and became established on some of the plantations near the mouth of the Mississippi river. From this point it has worked its way north to the district around New Orleans. Dr. Wm. C. Stubbs, formerly Director of the Louisiana Experiment Stations, states that the mealy-bug made its first appearance at the Sugar Experiment Station at Audubon Park, New Orleans, in 1891. It did not become established at the Station from this introduction for the reason that all infested canes were taken up and burned. Several years later a second introduction to the Sugar Experiment Station plats occurred. Because of the great value of the varieties infested, it became more practical to attempt control and exercise precautions in the distribution of seed cane than to take the rigid measures of eradication. These measures would have meant the destruction of the varieties in practically all of the Station plats with the reintroduction from outside almost a certainty. This would have been an irreparable loss to the Station and of no protection to the planter since the pest is well established in the surrounding plantations.

---

[1] Determined for the writer by Mr. J. G. Sanders, U. S. Bureau of Entomology, Washington, D. C.

[2] This is a common name applied to similar insect pests of sugar-cane in some other countries. In Mauritius and Bourbon the name *pou blanc* and also *pou a poche blanche* is applied collectively to two species of related insects, *Icerya seychellarium* (*sacchari*), Westw., and *Pulvinaria* (*Gasteralpha*) *iceryi*, Guer., infesting sugar cane. (See Sugar: A Hand Book for Planters and Refiners, Newlands, London, 1909, pp. 88, 89). The term more properly belongs to the latter species, since it was first recorded under the name *Le Pou a poche blanche* in 1862. (See Coccidae of the World, Fernald, Amherst, Mass., 1903, p. 133.)

OCCURRENCE IN LOUISIANA.

In the fall of 1907 an inspection of the cane at the sugar houses and in the plantations proved Jefferson, Plaquemines and Orleans parishes to be infested by the mealy-bug. Inspections showed no infestation in West Baton Rouge, Iberville, Ascension, Assumption, Terrebonne and St. Mary parishes. *Planters in the uninfested parishes should not secure seed cane from any of the above infested parishes.*

OCCURRENCE IN OTHER COUNTRIES.

The mealy-bug has been reported from Florida, California, New Zealand, Fiji Islands, Hawaiian Islands and Jamaica.

PLANTS ATTACKED.

The writer has observed the sugar-cane mealy-bug, aside from sugar-cane, on Johnson grass, *sorghum halepense,* and the saccharine sorghums. Mrs. Fernald records the species on *Calceolariae; Danthonia, Phormium tenax, Cordyline australis* and sugar-cane.[3]

---

[3] Fernald, Coccidae of the World, 1903, p. 98.

LIFE HISTORY.

The following observations were made by the writer during the season of 1907-1908 at Audubon Park, New Orleans:

The females while quite young are fertilized by the small winged males and, normally, begin to deposit eggs when about three-fourths grown. If detached from the host plant and prevented from reattaching, they will spin or exude the cottony mass and deposit eggs when not more than half mature. This seems to show that in order to perpetuate the species eggs are deposited a good while before they normally would be in case the life of the insects were not in danger. Under normal conditions it was observed that a female would begin to exude the white secretion and oviposit in about twenty-one days from time of hatching, however, when detached from the host plant oviposition would begin seven to ten days earlier. Under the latter conditions only a few eggs would be laid. By counting the eggs in many of the masses it was found that from 100 to 400 eggs were deposited in a single mass under normal conditions.

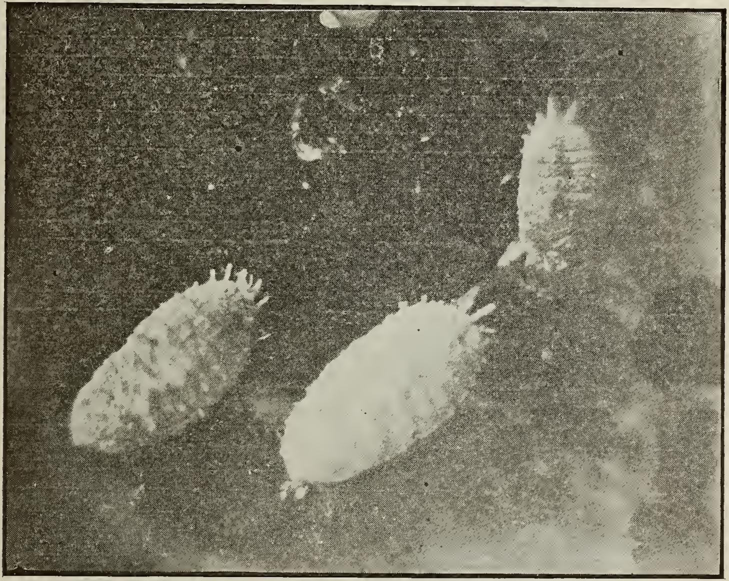


FIG. 1.—Adult female mealy-bugs *Pseudococcus calceolariae.* Enlarged. (Original.)

The cottony-looking secretion apparently exudes from the sides and posterior end of the abdomen and becomes quite large before egg-laying begins. The mass continues to increase gradually in size until egg-laying has ceased. At this time the white mass is larger than the body of the insect and the body is almost completely enveloped by it. The eggs are also completely covered and protected by the mass. The eggs hatch in from four to seven days in warm weather, depending on the temperature and humidity. In cool weather the length of time is greatly increased.

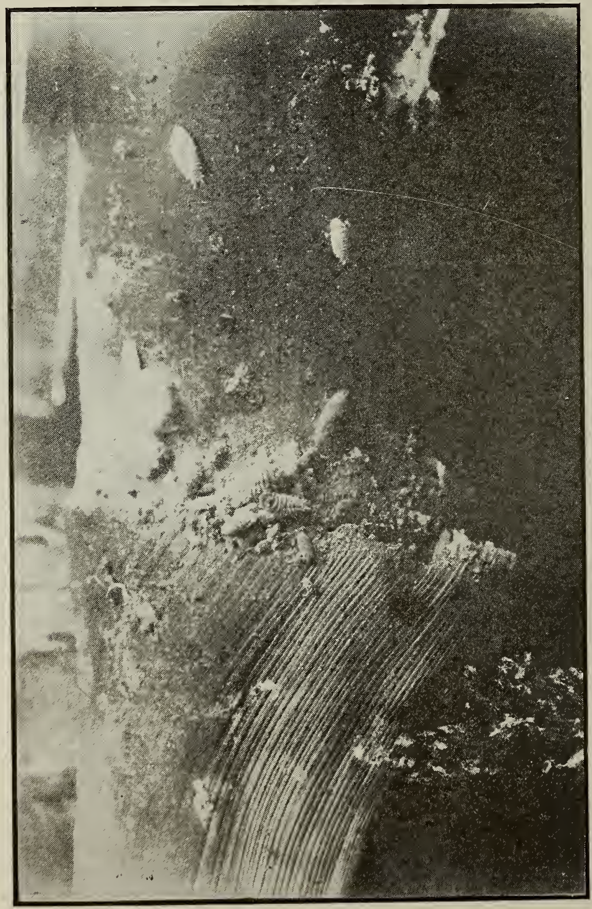


FIG. 2.—Adult and immature mealy-bugs, *Pseudococcus calceolariae*, around joint of mature cane stalk. Enlarged. (Original.)

The young nymphs or larvae when first hatched are very minute, measuring about .38 mm. in length, and for a day or two after hatching remain under the egg protecting mass. Gradually they emerge and crawl actively about over the plant until a good place for attachment is found. The point of attachment is generally near the top of the stalk where the joints are tender and easy for the insertion of the beaks of the young nymphs. The young females then collect in masses around the nodes or joints of the cane and fasten themselves to the cane plant by inserting their long thread-like beaks into the tissues from which the juices are extracted for food. The amount of juice extracted in this way is in excess of the actual needs of the mealy-bug and the surplus is secreted from the body of the insect in the form of a sweet substance known as "honey-dew." In the early spring before the young canes have begun to joint, the young mealy-bugs, which hatch at that time, crawl up and attach themselves in the leaf axils and get subsistence from the leaves.[4] The development of the insects is much slower while feeding on the sap in the leaves than while feeding on the saccharine juices in the stalks. The mealy-bugs prefer the stalk to the leaves and will leave the leaf axils and go to the nodes as soon as the jointing of the cane takes place. When once attached at the node on the stalk, the insect, if undisturbed, seems inclined to remain there throughout its life.

The males hatch in the same cottony mass with the females and resemble the latter quite closely at first, but after about five days from time of hatching they also collect by themselves under some leaf sheath, or other place of hiding, and begin to spin a long, narrow, white cocoon. In this cocoon they remain until fully matured, emerging in about fourteen days in possession of two clear, delicate wings and a pair of long, white, anal spines. When mature the males begin to fly in search of females and can be seen literally swarming around heavily infested stalks of cane.

The broods follow one after the other throughout the summer and until cold weather in the fall or winter. As long as cane stands without being killed by freezes, slow development of the insects will continue. During the winter of 1907-'08 a few rows of cane were left standing until March at the Sugar Experiment Station at New Orleans. During that time the canes remained heavily infested and the young mealy-bugs gradually reached maturity. The weather was not severely cold and the canes were never frozen enough to cause very much fermentation of the juice. Development also continued in the case of insects which were in hibernation or underground on the windrowed canes and stubble. Mr. D. L. Van Dine, of the United States Bureau of Entomology, who is located at Audubon Park in charge of co-operative work on sugar-cane insects, informs me that this past winter (1910) all cane left standing was killed above the ground by frost, even some protected by a shelter. The cold and lack of food forced the mealy-bug down among the roots and development practically ceased during January, February and part of March. However, when the cane was removed from the windrow, Mr. Van Dine states that development, though doubtless retarded, had continued beneath the ground on the cane thus protected.

---

[4] See Fig. 4, which shows the mealy-bugs attached to the leaf axils of cane with a covering of dirt made by the "Argentine" ant.

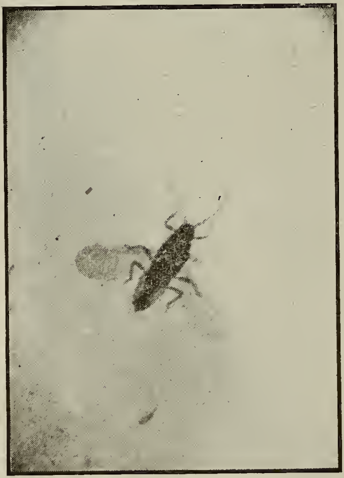


FIG. 3.—Adult male mealy-bug, *Pseudococcus calceolariae.* Enlarged. (Original.)

HIBERNATION.

During harvest time, which begins in October, the infestation is usually very heavy and in cutting and stripping the cane of its leaves countless thousands of the mealy-bugs are detached and fall to the ground to perish. Some of them make their way below ground and attach themselves to the stubble where the old females deposit eggs. The eggs will hatch thereafter, the time depending on the temperature, and then for five or six months the struggle for existence begins with these young nymphs. Some of them successfully pass through and emerge the following June or July to begin rapid reproduction, but the greater proportion of them die before spring. Those which are carried to the mill on the cane are of course crushed in the grinding, but many of them are dropped on the way to the sugar house, and if Johnson grass is plentiful along the road some of them will pass the winter on that plant and then spread to the sugar-cane the following spring.

When cane is planted in the fall thousands of the insects and their eggs are planted with it, but they are placed in such close contact with the wet soil and have such poor protection that their chances for surviving through a wet, cold, winter on fall plant cane are not near so good as they are when placed in a windrow and then planted with the cane the following spring. The most favorable hibernating place of the mealy-bug is in the windrowed seed cane, for these canes are cut in October when heavily infested, and, without having any of the leaves stripped, are piled in masses between the rows and covered with dirt. Consequently most of the mealy-bugs remain attached to the stalks just as they were while the canes were standing. There is such an abundance of stalks and leaves heaped together that circulation of the air readily takes place, drainage is accelerated, and, therefore, the hibernating quarters are dried out enough to make them very favorable. Some of the eggs hatch in the windrow and the nymphs or young continue to extract juice and slowly develop through the winter. When windrowed cane is taken up for planting in the spring, there are many of the insects still attached to it and consequently are transferred from the windrow to the field where they are again put under ground on the plant cane. Soon after spring planting the weather warms up, the cane germinates and the underground mealy-bugs attach themselves to the germinating eyes where most of them remain until the cane begins to joint above ground.

They then gradually emerge from their subterranean places of attachment and reattach themselves to the nodes above ground.

Some of the mealy-bugs make their appearance above ground quite early in the summer, but the greater part of them do not appear until jointing of the cane begins. Those which come out before jointing begins attach themselves in the leaf axil. The "Argentine" ant, *Iridomyrmex humilis,* Mayr., is a very abundant and serious pest in some localities. Where it occurs, the ant lends its assistance to the mealy-bug by carrying up dirt and plastering it over the colonies and this protects them from enemies, cold, rain and light (see fig. 4).

The mealy-bugs prefer a dark situation and always try to find a suitable place where they will be covered by the leaf sheath, but since in the early spring the cane has no joints, and hence has all of the leaf sheaths wrapped tightly together, there are no hiding places. But for the assistance of the "Argentine" ant they would be forced to attach without protection. These ants, countless numbers of them, constantly attend the mealy-bugs and give them protection in order to collect the sweet exudation, known as "honey-dew," given off by these insects. They not only collect what is normally given off, but they approach the mealy-bugs, and, stopping at the anal end of the body, begin to strike the mealy-bug with the antennae and continue the operation until the "honey-dew" is given up. It is immediately collected and the ant then goes in search of another mealy-bug from which it may procure more "honey-dew," and so on it travels until it has completely filled its abdomen with this clear sweet substance.

DISSEMINATION.[5]

The greatest danger of disseminating the sugar-cane mealy-bug is through the transportation of infested cane from plantation to plantation or from one part of the State to another. The

---

[5] There are other common species of mealy-bugs which are mistaken for the sugar-cane mealy-bug by the layman. In this State none of these species attack sugar-cane and the sugar-cane species, so far as the writer has been able to observe, does not attack any plants in Louisiana other than sugar-cane, Johnson grass and sweet sorghums. There is practically no danger, therefore, in disseminating this pest on other plants than sugar-cane. The other species occur on such plants as the orange, fig, persimmon, guava, and various ornamental plants, but they do not attack sugar-cane.

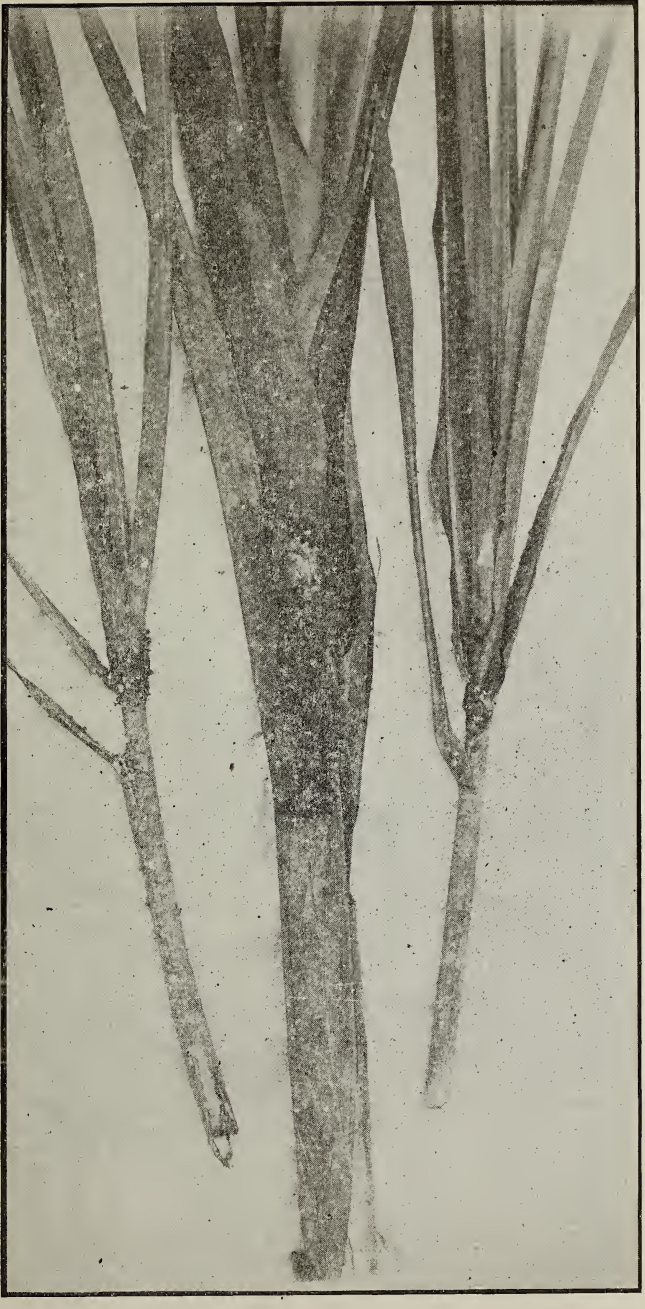


Fig. 4.—Ant shelters made of dirt to protect the mealy-bug, *Pseudococcus calceolariae*. Notice that this cane has not jointed and that the mealy-bugs are attached in the leaf axils. (Original.)

very small insects fasten themselves under the leaf sheaths, or even under the eyes of the cane, and could easily remain there while being transported almost any distance. The eggs, being well protected by the cottony covering, if deposited under a leaf sheath could also be carried from one place to another on seed cane very easily. They probably have been disseminated in the plantations below New Orleans in this way.

It is possible for the young nymphs to be spread in an infested field or from an infested one to an adjoining uninfested one on the feet of birds, on seed cane, by plowmen or plow teams, by hauling cane through the field to the sugar house or by the wind. This latter agency is responsible no doubt for some of this dissemination for the minute insects crawl about over the leaves of the plant and it would seem could be easily blown from them to nearby plants. Observations in the field during 1908 indicated that this is a means of dissemination in an infested field or from an infested one to an adjoining uninfested field.

In order to prevent this pest from being carried to fields which are now uninfested, all planters should be very careful not to secure seed cane from other plantations which are infested or procure infested canes from an infested field on their own plantations.

AMOUNT OF DAMAGE.

The greatest damage by the sugar-cane mealy-bug is to the germinating eyes or buds on the plant cane in the spring. Where the cane is heavily infested when put into the windrow in the fall and a mild, dry winter follows, many of the eyes will be killed and many others will have their vitality so exhausted by the continued extraction of the sap that growth of the young cane will be greatly retarded and the resulting crop correspondingly injured.

It is very difficult to estimate the amount of damage caused by this pest. The damage caused by the mealy-bug on sugar-cane varies according to the variations in seasons and in proportion to the manner in which remedial and preventive measures are employed. Some years the damage is large and in others it is small, depending upon whether the planter makes a fight against

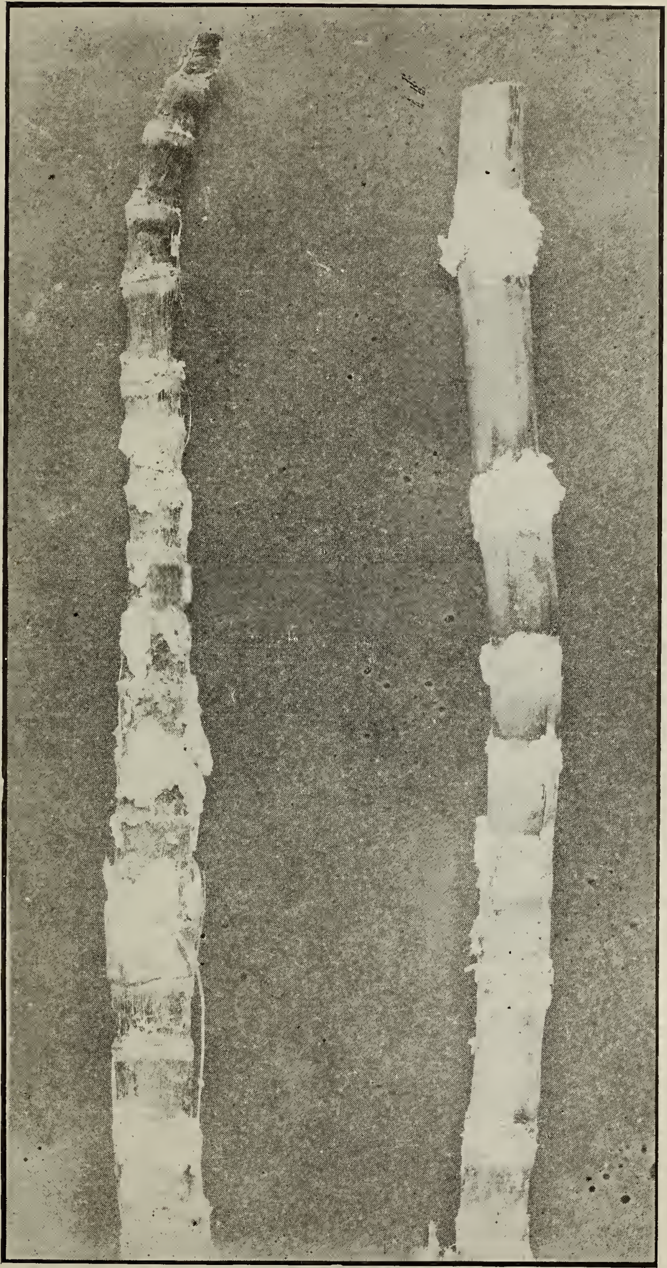


FIG. 5.—Stalks of cane badly infested with mealy-bug, *Pseudococcus calceolariae.* Notice that the mealy-bugs are attached around the nodes or joints. The white masses are not the insects themselves, but are the secretions of the insects which cover the eggs. (Original.)

the insect or not. This is for the reason that some years are very favorable because of natural agencies which hold the pest in check, whereas in other years the climatic conditions and other factors are very favorable for the development of the insect and not favorable for the natural enemies, and when this occurs the greatest damage results.

In late summer and fall, when the infestation becomes heavy, a great deal of juice, which at that time contains a large amount of sucrose, is sucked out and that means a loss of sugar and the retardation of plant growth. This damage is not as serious as that to the eyes or germs in the early spring for it is on these that the stand depends. Retardation of growth and injury to the young delicate canes at the time of germination is not easily overcome. From the experience at the Station, however, it seems that particularly favorable winters for the development of this pest are of rather infrequent occurrence in the sugar belt of Lou-

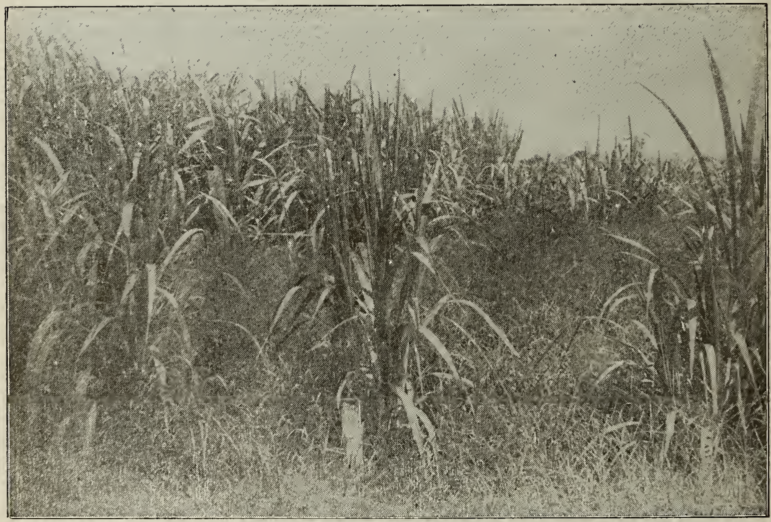


Fig. 6.—An irregular stand of cane, some of which was no doubt caused by the sugar-cane mealy-bug, *Pseudococcus calceolariae*. (2d Biennial Rept. Sec. State Crop. Pest Com. of La.)[6]

---

[6] In his second Biennial Report of the State Crop Pest Commission of Louisiana the Secretary states that the irregular stand of cane shown in Fig. 6 was caused by the destruction of the buds or eyes of the plant cane by the sugar-cane mealy-bug. While the mealy-bug no doubt assisted in causing this irregular stand of cane, it is quite probable that other factors should have been considered and that all of the damage should not have been attributed to this insect.

isiana. The stands are not as seriously damaged during cold winters as they are during mild or open winters.

The presence of the ''Argentine'' ant makes a great difference in the infestation because of the protection which they give to the mealy-bug. More especially in the early spring is the ant quite a factor in increasing the numbers of the pest.

NATURAL ENEMIES AND DISEASES.

The lady-bird beetle, *Cryptolaemus montrouzieri* Muls., is an important enemy of this pest in Australia and Hawaii. It is a small beetle having a red head and thorax and dark brown elytra or wing covers. The lady-bird deposits its eggs in the cottony covering of the eggs of the mealy-bug and as soon as hatched the young lady-bird larvae begin to devour the eggs and nymphs around them. The young lady-bird larvae are small when first hatched but they have such ravenous appetites that growth is very rapid where the mealy-bugs are abundant enough to furnish a sufficient food supply. When fully mature the larvae are two or three times as large as the adult beetles and are covered with long, white, spines, giving them somewhat the appearance of the mealy-bugs. They crawl quite actively about over the cane and feed continually on the mealy-bugs and their eggs. From three weeks to a month is required to complete a generation of the lady-bird and the female beetle usually deposits about fifty eggs.

The long, white, spines on the lady-bird larvae is a protection against other insects. It was observed that the ''Argentine'' ant would always drive the adult beetle away from the mealy-bug but would rarely ever attack the lady-bird larvae. On a few occasions the ants were observed attacking the lady-bird larvae but always left after the first attack with their mandibles covered with pieces of the white spines from the bodies. No injury to the larvae themselves was noted.

A small number of these beetles were very kindly sent, upon our request, to the Experiment Station in March, 1908, by Mr. Edw. M. Ehrhorn, of the California State Board of Horticulture. They were liberated in the cane plats at the Sugar Station at Audubon Park, and multiplied very rapidly through the summer and were quite abundant when last observed about the middle of November, 1908. The lady-birds almost completely eradicated the mealy-bugs in the plats in which they were liberated. Mr. Van Dine informs me that these lady-birds were not to be found at the Station during the summer of 1909. Apparently they did not survive the cold of winter or it may be that they died out on account of a lack of mealy-bugs for food, since this species is very specialized in its feeding habits. Mr. Van Dine plans further introductions from California.

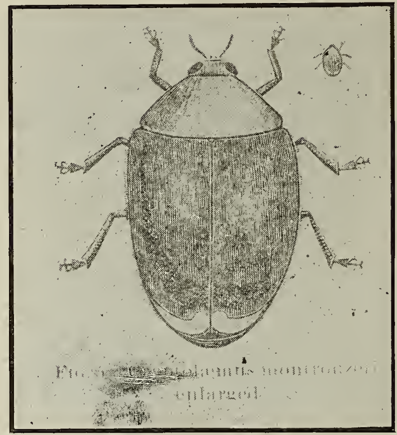


FIG. 7.—An adult lady-bird beetle *Cryptolaemus montrouzieri*, much enlarged. In upper right-hand corner natural size. (California Horticultural Commission.)

The only insect enemy of the mealy-bug of any importance which has been observed occurring naturally in the fields in this State is a small lady-bird, *Scymnus intrusus* Horn.[7] This insect, both in the adult and larval stages, resembles the Australian lady-bird, *Cryptolaemus montrouzieri*, very closely, but it is much smaller in size. Its life history and habits are also similar to that insect. The females do not seem to be very prolific, however, and consequently it does not become abundant enough to be a factor in controlling the mealy-bug.

---

[7] Determined by Mr. E. A. Schwarz, Bureau of Entomology, U. S. Dept. Agr.

The most important enemy coming under observation was a dark, green, fungus, an *Aspergillus*,[8] which kills a large per cent of the mealy-bugs during very wet weather. In July, August and September, 1908, the rainfall at the Sugar Station was 12.16, 5.49 and 11.7 inches respectively, and during those months this fungus was very abundant and destroyed a large per cent of the mealy-bugs. The disease is present throughout the year but serves as a factor in controlling the pest only during wet seasons. The months of October and November, 1908, were very dry and the effectiveness of the fungus in controlling this pest was reduced accordingly. As a general rule the precipitation is quite heavy during the cane growing season, and, therefore, we may expect this fungus to continue to be a factor in controlling this enemy of the sugar-cane.

METHODS OF CONTROL.

The methods of propagating the sugar-cane and the nature of the insect render the use of remedial measures such as sprays and washes impracticable. It passes the winter on the cane stalks and stubble underground where good protection is afforded by the ground and the leaf sheaths on the windrowed cane. Emergence from this subterranean situation does not occur, that is, maximum emergence, until the cane is quite large and full of foliage and leaf sheaths and this affords such splendid protection that it would be entirely impracticable to apply any kind of spray that would reach this pest.

All of the seed cane planted at the Sugar Station since the fall of 1906 has been washed with whale oil soap emulsion. This treatment has greatly reduced the numbers of the pest which otherwise would have attacked the germinating eyes in the spring. It also greatly delayed the time of maximum infestation the following summer. In that way much of the damage to stands has been avoided, but such procedure, where large amounts of cane are to be planted, would be impracticable and too expensive.

Fumigation with bisulphide of carbon was also tried. Where the cane was subjected to the fumes for an hour the insects were killed, but the eggs were not injured. This method also would not be practical for use by the Louisiana planter. *In order to prevent the further spread of the mealy-bug, it is important that an effective treatment for infested seed cane intended for distribution be devised.* In the fall of 1909, Mr. Van Dine began a series of experiments with standard insecticides along this line. When completed these results will be published for the benefit of the planter.

---

[8] Determined by Dr. C. W. Edgerton, Louisiana Experiment Stations.

In fields which are heavily infested, in order to avoid as much damage as possible to the germinating eyes, the greater portion of the crop should be planted in the fall. Fall plant cane does not afford as favorable winter quarters as windrowed cane and the experiments at the Staion have shown that fall plant, when the ground was not too dry and labor plentiful enough to prepare the soil properly, gave better results and better stands than spring plant. The stand from the fall plant at the Station during 1907-08 was decidedly better than the stand was from the seed planted in the spring.

The weather being dry enough to permit it, all of the cane tops and leaves remaining on the ground after the cane is hauled from the field should be immediately burned because this will destroy large numbers of the mealy-bugs and their eggs which fall from the cane stalks while they are being cut, stripped and loaded on the wagon. If the mealy-bugs are not destroyed in this way they crawl to the stubble or windrowed cane and there pass the winter and emerge the following summer to continue their reproduction. The burning not only does good in controlling the mealy-bug but also destroys thousands of the larvae of the cane stalk-borer in the cane tops which are always left on the ground in the fields. The borer is by far the most injurious enemy of the cane in Louisiana and since the larger per cent of them hibernate in the old cane tops left in the field after harvest, the destruction of the tops is absolutely necessary whether the mealy-bug is present or not.

All of the Johnson grass along the ditch banks and roads should also be thoroughly burned during the dry spell in the fall since the mealy-bugs which get on that grass will be situated among the bases of the plants just at the surface of the ground and burning off the grass will destroy them. As the cane borer also attacks Johnson grass the burning would destroy all of those which happen to be in it at that time.

The Bureau of Entomology of the United States Department of Agriculture, has established a co-operative laboratory at the Sugar Experiment Station at Audubon Park for further work on the sugar-cane mealy-bug and other insects affecting sugar-cane under the direction of Mr. D. L. Van Dine. The work of this laboratory on the sugar-cane mealy-bug will deal particularly with the treatment of infested seed cane intended for distribution to prevent the further spread of the pest, and, if possible, work out a practical treatment for seed cane in infested localities and also the exact relationship between the mealy-bug and the Argentine ant.

The writer wishes to acknowledge assistance and suggestions given by Mr. D. L. Van Dine in the preparation of this preliminary report.

Louisiana Bulletin No. 122. July, 1910.

Agricultural Experiment Station

OF THE

Louisiana State University and A. & M. College,

BATON ROUGE.

Rough Rice as Feed for Horses and Mules.

BY

W. H. DALRYMPLE, M. R. C. V. S.,

Veterinarian.

BATON ROUGE
THE NEW ADVOCATE, OFFICIAL JOURNAL
1910

Louisiana State University and A. & M. College

Louisiana State Board of Agriculture and Immigration

EX-OFFICIO.

GOVERNOR JARED Y. SANDERS, *President.*
HENRY L. FUQUA, *Vice-President of Board of Supervisors.*
CHAS. SCHULER, *Commissioner of Agriculture and Immigration.*
THOMAS D. BOYD, *President State University.*
W. R. DODSON, *Director Experiment Stations.*

MEMBERS.

R. S. Moore, St. Bernard.
Henry Gerac, Lafayette.
John T. Cole, Monroe.
John J. Henderson, Lagan.
R. E. Thompson, Wilson.
Jeff D. Marks, Crowley.

STATION STAFF.

W. R. DODSON, A. B., B. S., Director, Baton Rouge.
HAMILTON P. AGEE, B. S., Assistant Director, Audubon Park, New Orleans.
S. E. McCLENDON, B. S., Assistant Director, Calhoun.
FRIEND C. QUEREAU, B. S., Ass't Director Rice Exp'ment Station, Crowley.
W. G. TAGGART, B. S., Assistant Chemist, Audubon Park, New Orleans.
WM. G. OWEN, B. S., Bacteriologist, Audubon Park, New Orleans.
J. K. McHUGH, Secretary and Stenographer, Audubon Park, New Orleans.
J. E. HALLIGAN, B. S., Chemist, Baton Rouge.
H. L. GREEN, B. S., Assistant Chemist, Baton Rouge.
A. P. KERR, B. S., Assistant Chemist, Baton Rouge.
R. BAUS, B. S., Assistant Chemist, Baton Rouge.
R. G. FULLER, B. S., Assistant Chemist, Baton Rouge.
R. G. TILLERY, B. S., Assistant Chemist, Baton Rouge.
P. H. DOHERTY, B. S., Assistant Chemist, Baton Rouge.
ROGER P. SWIRE, A. B., Treasurer, Baton Rouge.
J. B. GARRETT, B. S., Entomologist, Baton Rouge.
G. L. TIEBOUT, B. S., Horticulturist, Baton Rouge.
W. H. DALRYMPLE, M. R. C. V. S., Veterinarian, Baton Rouge.
C. W. EDGERTON, Ph. D., Plant Pathologist, Baton Rouge.
E. W. KERR, M. E., Professor Mechanical Engineering, Baton Rouge.
T. C. PAULSEN, B. S., M. D. C., Assistant Veterinarian and Bacteriologist.
J. T. TANNER, A. B., Secretary and Stenographer, Baton Rouge.
IVY WATSON, Farm Manager, Calhoun.
E. J. WATSON, Horticulturist, Calhoun.
HY. STAPLES, in charge of Dairy, Baton Rouge.
V. L. ROY, B. S., in charge of Boys' Demonstration Work.

Rough Rice as Feed for Horses and Mules.

BY W. H. DALRYMPLE.

The Veterinary Department of the Experiment Stations has received requests, from time to time, to give an opinion with respect to the suitability and safety of rough rice as a feed for horses and mules.

The Department has been aware that in the rice-growing section of the State, viz., Southwestern Louisiana, rough rice has been used as feed, yet we were not in possession of any accurate or intelligent data concerning its physical effect upon the digestive organs; and it would seem that the prevailing opinion, or impression, of a possible deleterious physical effect has been based upon the presence of the somewhat silicious nature of the hull enclosing the rice kernel.

Considering the fact that, at times, when other cereal grains used as horse and mule feed, such as oats, corn, etc., are high in price, and the cost of rice low, in the producing sections, it was thought the latter might, by intelligent use, become of considerable economic value as a feed in those sections, or, indeed, outside of them.

Again, in looking a little more closely into the matter of crude fibre content, we could not quite see why rough rice, with an average crude fibre analysis of 9.3 per cent. should be any more dangerous to feed, or affect the digestive organs of the animal more injuriously, than a rice bran containing 15 per cent. of rice hulls, and showing an analysis of 14.5 per cent. of crude fibre, which, in reality, indicates a much higher content of crude fibre than is contained in the rice grain itself.

In April last the Veterinary Department of the Stations, at Baton Rouge, determined to conduct a test, using two of the work mules, in order to obtain some accurate information on the subject for the benefit of those seeking such data in the future, and to be able to either verify or contradict an, apparently, prevalent impression that rough rice is injurious when fed to horses and mules.

Through the Rice Experiment Station, at Crowley, La., this Department procured five sacks of ground rough rice for the test. Rations for the two mules were compounded, gradually increasing the amount of rice at intervals until 8 pounds, or a little over, were fed to each mule per day.

This gradual increase in the rice ingredient of the ration was decided upon as a matter of caution, and to watch the deleterious effect, if any, during the progress of the test.

The ration was balanced to meet the requirements of a mule weighing 1,000 pounds and doing medium, or moderately heavy work, per day, and was composed of rough rice (ground), cracked corn, cotton seed meal, cane molasses (blackstrap), and lespedeza hay. As the rice in the ration was increased, the cracked corn was decreased, until 8 pounds of rice were fed, without any corn. The other ingredients remained the same in quantity.

The initial ration, for one day, contained the following:

			Digestible		
		Dry Matter.	Protein.	Carbohydrates.	Fat.
Lbs.		Lbs.	Lbs.	Lbs.	Lbs.
2	Rough rice (ground)	1.70	0.09	1.20	0.06
6	Cracked corn	5.36	0.47	4.00	0.25
1½	Cotton seed meal	1.38	0.56	0.25	0.18
4	Molasses (blackstrap)	3.12	0.00	2.64	0.00
12	Lespedeza hay	10.68	0.96	5.04	0.24
		22.24	2.08	13.13	0.73

Nutritive Ratio, 1:7.0

It should be here stated that although the above and all the subsequent rations, was based upon 12 pounds of lespedeza hay as roughage, the animals received only a moderate amount of grazing when turned out at night. Also, that each day's concentrated part of the ration was divided into three parts. On Sundays the mules received only morning and night feeds and were allowed to graze during the day.

Further, so far as we are aware, no digestion expriments have been conducted with rough rice to ascertain the digestion co-efficients, or percentage digestibility, of its crude protein, carbohydrates and fat.

By reference to any published table showing the percentage composition of rough rice and corn and cob meal, however, it will be found that the composition of the latter is sufficiently approximate to that of the former to enable us to apply, for all practical purposes, the percentage digestibility of corn and cob meal to the rough rice, which we have done in the conduct of this test, and with apparently satisfactory results.

On April 25th, 1910, two aged mules, which we shall name, respectively, "Bet," weighing 815 pounds, and "Mack," weighing 940 pounds, were given the initial ration shown above. "Mack," being rather fastidious in his taste, declined to eat the mixture, which was quite a change from his previous feed, and on May 2d a much younger mule, "Rhoda," weighing 1,155 pounds, was substituted, and she and "Bet" continued the test mules throughout the experiment.

WEIGHT AND CONDITION OF MULES.

May 2.	Lbs.	Condition.
"Bet"	820	Improved
"Rhoda"	1,155	Good

MAY 6. SECOND RATION.

			———Digestible———		
		Dry Matter. Lbs.	Protein. Lbs.	Carbohydrates. Lbs.	Fat. Lbs.
Lbs.					
4	Rough rice	3.96	0.18	2.40	0.12
4	Cracked corn	3.58	0.31	2.67	0.17
1½	Cotton seed meal	1.38	0.56	0.25	0.18
4	Molasses	3.12	0.00	2.64	0.00
12	Lespedeza hay	10.68	0.96	5.04	0.24
		22.72	2.01	13.00	0.71

Nutritive Ratio 1:7.2 plus.

May 17.	Weight. Lbs.	Condition.
"Bet"	825	Improved
"Rhoda"	1,154	Good—stationary

MAY 17. THIRD RATION.

			———Digestible———		
		Dry Matter. Lbs.	Protein. Lbs.	Carbohydrates. Lbs.	Fat. Lbs.
Lbs.					
5	Rough rice	4.24	0.22	3.00	0.12
3	Cracked corn	2.68	0.23	2.00	0.13
1½	Cotton seed meal	1.38	0.56	0.25	0.18
4	Molasses	3.12	0.00	2.64	0.00
12	Lespedeza hay	10.68	0.96	5.04	0.24
		22.10	1.97	12.93	0.67

Nutritive ratio, 1:7.3 plus.

May 25.	Weight. Lbs.	Condition.
"Bet"	826	Improved
"Rhoda"	1,152	Good—stationary

MAY 26. FOURTH RATION.

Lbs.		Dry Matter. Lbs.	Digestible Protein. Lbs.	Digestible Carbohydrates. Lbs.	Digestible Fat. Lbs.
6	Rough rice	5.00	0.26	3.60	0.17
2	Cracked corn	1.79	0.16	1.34	0.08
1½	Cotton seed meal	1.38	0.56	0.25	0.18
4	Molasses	3.12	0.00	2.64	0.00
12	Lespedeza hay	10.68	0.96	5.04	0.24
		22.06	1.94	12.87	0.67

Nutritive ratio, 1:7.3 plus.

May 31.	Weight. Lbs.	Condition.
"Bet"	832	Improved
"Rhoda"	1,150	Good. Slightly off feed

JUNE 1. FIFTH RATION.

Lbs.		Dry Matter. Lbs.	Digestible Protein. Lbs.	Digestible Carbohydrates. Lbs.	Digestible Fat. Lbs.
7	Rough rice	5.94	0.31	4.20	0.20
1	Cracked corn	0.89	0.08	0.67	0.04
1½	Cotton seed meal	1.38	0.56	0.25	0.18
4	Molasses	3.12	0.00	2.64	0.00
12	Lespedeza hay	10.68	0.96	5.04	0.24
		22.01	1.91	12.80	0.66

Nutritive ratio, 1:7.5

June 7.	Weight. Lbs.	Condition.
"Bet"	825	Good. Slightly off feed
"Rhoda"	1,155	Improved

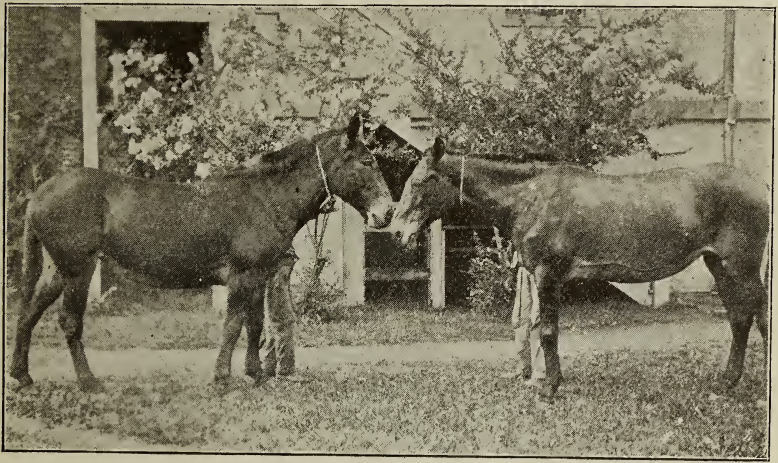
JUNE 7. SIXTH RATION.

Lbs.		Dry Matter. Lbs.	Digestible Protein. Lbs.	Digestible Carbohydrates. Lbs.	Digestible Fat. Lbs.
8	Rough rice	6.79	0.35	4.80	0.23
1½	Cotton seed meal	1.38	0.56	0.25	0.18
4	Molasses	3.12	0.00	2.64	0.00
12	Lespedeza hay	10.68	0.96	5.04	0.24
		21.97	1.87	12.73	0.65

Nutritive ratio, 1:7.6

June 25.	Weight. Lbs.	Condition.
"Bet"	828	Improved
"Rhoda"	1,150	Good—work, harder; weather hot.

The sixth ration was continued until the end of the test, June 30th, when the two mules had practically consumed the five sacks of rice, with the slight exception that the larger mule, "Rhoda," on account of her greater weight, was given, commencing June 10th, 1 lb. more of the rice and cotton seed meal mixture than the smaller mule.



"RHODA." "BET."

(Photos taken on completion of test.)

June 30.	Weight. Lbs.	Condition.
"Bet"	851	Improved
"Rhoda"	1,155	Improved

CONCLUSIONS.

The size of the ration employed was more suited to the requirements of the lighter mule than of the heavier one, although the latter seemed to maintain her weight on it. Had the specified amount of hay (12 pounds) in the ration been consumed, instead of only moderate grazing as roughage, the heavier mule might, probably, have increased her weight.

The general health and condition of both mules were excellent throughout the test, with the exception of one or two "off days" due to hot weather. In fact, the mule "Bet," which has been on the Station for in the neighborhood of fifteen years, has never been known to be in such regularly good and uniform physical condition. The mule "Rhoda" was a comparatively recent purchase.

Rough rice, when ground, and forming one of the ingredients of a mixed ration, may be fed with safety and benefit to horses or mules.

The day's ration may be composed of at least 8 pounds of ground rough rice for horses or mules doing moderately heavy work and approximating 1,000 pounds live weight.

The other ingredients in the test rations proved suitable to mix with the ground rough rice, although other available materials, if of the required composition to balance the ration, might be just as satisfactory.

When the prices of other cereal (feeding) grains are high, etc., and other conditions warrant, ground rough rice may be found of considerable economic value as a feed for horses or mules, if intelligently and systematically used.

Louisiana Bulletin No. 123 October, 1910.

Agricultural Experiment Station

OF THE

Louisiana State University
and A. & M. College,

BATON ROUGE.

SOME EXPERIMENTS IN GRAZING AND SOILING

BY

S. E. McCLENDON, B. S.,
Assistant Director.

BATON ROUGE
THE NEW ADVOCATE, OFFICIAL JOURNAL
1910

Louisiana State University and A. & M. College

Louisiana State Board of Agriculture and Immigration

EX-OFFICIO.

GOVERNOR JARED Y. SANDERS, *President.*
HENRY L. FUQUA, *Vice-President of Board of Supervisors.*
CHAS. SCHULER, *Commissioner of Agriculture and Immigration.*
THOMAS D. BOYD, *President State University.*
W. R. DODSON, *Director Experiment Stations.*

MEMBERS.

R. S. MOORE, St. Bernard.
HENRY GERAC, Lafayette.
JOHN T. COLE, Monroe.
JOHN J. HENDERSON, Lagan.
R. E. THOMPSON, Wilson.
JEFF D. MARKS, Crowley.
J. E. BULLARD, Belmont.

STATION STAFF.

W. R. DODSON, A. B., B. S., Director, Baton Rouge.
HAMILTON P. AGEE, B. S., Assistant Director, Audubon Park, New Orleans.
S. E. McCLENDON, B. S., Assistant Director, Calhoun.
FRIEND C. QUEREAU, M. S., Ass't Director Rice Exp'ment Station, Crowley.
W. E. CROSS, Chemist, Audubon Park, New Orleans.
W. G. TAGGART, B. S., Assistant Chemist, Audubon Park, New Orleans.
R. E. GRAHAM, B. S., Assistant Chemist, Audubon Park, New Orleans.
WM. G. OWEN, B. S., Bacteriologist, Audubon Park, New Orleans.
J. K. McHUGH, Secretary and Stenographer, Audubon Park, New Orleans.
J. E. HALLIGAN, B. S., Chemist, Baton Rouge.
A. P. KERR, M. S., Assistant Chemist, Baton Rouge.
R. BAUS, B. S., Assistant Chemist, Baton Rouge.
R. G. FULLER, B. S., Assistant Chemist, Baton Rouge.
R. G. TILLERY, M. S., Assistant Chemist, Baton Rouge.
P. H. DOHERTY, B. S., Assistant Chemist, Baton Rouge.
G. D. CAIN, B. S., Assistant Chemist, Baton Rouge.
ROGER P. SWIRE, Treasurer, Baton Rouge.
J. B. GARRETT, B. S., Entomologist, Baton Rouge.
G. L. TIEBOUT, B. S., Horticulturist, Baton Rouge.
W. H. DALRYMPLE, M. R. C. V. S., Veterinarian, Baton Rouge.
C. W. EDGERTON, Ph. D., Plant Pathologist, Baton Rouge.
E. W. KERR, M. E., Professor Mechanical Engineering, Baton Rouge.
H. A. NADLER, B. S., Assistant Mechanical Engineering, Baton Rouge.
T. C. PAULSEN, B. S., M. D. C., Assistant Veterinarian and Bacteriologist.
J. T. TANNER, B. A., Secretary and Stenographer, Baton Rouge.
WALTER McCLENDON, Farm Manager, Baton Rouge.
EWELL CAMP, Mailing Secretary, Baton Rouge.
IVY WATSON, Farm Manager, Calhoun.
E. J. WATSON, Horticulturist, Calhoun.
HENRY STAPLES, in charge of Dairy, Baton Rouge.
T. J. WEAVER, Gardener, Baton Rouge.

Some Experiments in Grazing and Soiling.

BY

S. E. McClendon, B. S., Assistant Director.

For a number of years all the Louisiana experiment stations have been devoting more or less attention to growing forage crops, and special attention has been devoted to those at Baton Rouge. The earlier experiments were devoted to testing the relative yields in hay or green forage, best time of planting seed, time required for maturity, etc., of different varieties. The most important results of these experiments have been published from time to time. More recently some of the best forage and soiling crops have been pastured or fed, and the returns measured by gain in weight of the animals consuming the crops. Cattle, hogs and sheep have been used in these experiments. While the results are not quite as complete as desired, we are prompted to publish some of the data in hand at this time, because of an active demand for information along these lines.

OATS AS A PASTURE CROP FOR HOGS AND SHEEP.

In 1907 a plot of land at Baton Rouge measuring two and a half acres that had produced one hundred and ten bushels of corn was used for the following winter grazing experiment:

The corn was gathered on September 2. Then the land was pastured with cattle to clean the field. On September 26 and 27 this land was plowed with a three-mule disc plow, turning under all the left-over corn stalks, grass, etc. On the 28th this land was planted in Patterson rust-proof oats.

On October 29 seven Poland-China pigs, weighing 276 pounds, were put on these oats for the winter without other feed. Up to this time the pigs had not been fed, but had been running through the fence into a pea field and were in fine growing condition. On February 17, 1908, these pigs weighed 568 pounds, having made a gain of 292 pounds in one hundred and ten days' time on oats alone. This would be an average daily gain of .37 pounds per pig. The experiment was closed at this time, as we wished to prepare the land for the early planting of corn.

These pigs could have been sold at this time for 6 cents gross, or the 292 pounds of pork was worth $17.52. Forty-five head of sheep were pastured about one-half the time from October 29 to January 1 on the same plot to help keep the oats down. No account was kept of their gains. After January 1, 1908, we confined with the seven pigs, eight ewes and nine lambs. On February 17 the nine lambs weighed 320 pounds, and the ewes were in better condition than on January 1, when confined to the plot without additional feed. These lambs averaged sixty-eight days old and weighed 35.5 pounds each. The oldest lamb was one hundred and eleven days old and weighed sixty pounds, the youngest one being forty-eight days old. These lambs were worth 5 cents gross, or $16.00. This gives a total credit of $33.52 to this piece of land, not counting the extra pasturage up to January 1. This amounts to $13.40 per acre, without interference with the crops that were to follow.

The cost of producing this winter pasture was approximately as follows:

Man and team, 2 1-2 days at $3 per day....	$ 7.50
Five bushels of seed oats at 75c............	3.75
Seeding oats	.25
Shoveling drains	.50
Total cost	$12.00

At this rate an acre of oats would be worth $8.60 for pasture alone for one hundred and ten days, after the expense of production had been deducted.

PIGS ON DRY FEED.

May 5, 1905, fifteen pigs were distributed into three groups, as nearly equal in size as possible, and put in three separate pens, and fed as follows:

Lot No. 1, weight May 5, 498 pounds, were fed 20 pounds of rice bran daily until May 15, when the lot weighed 500 pounds, a gain of two pounds in ten days. The feed was then increased to thirty pounds daily. May 21, the lot weighed 546 pounds. On May 29, the feed was increased to 40 pounds daily. June 3, the lot weighed 596 pounds. Total gain in weight, 29 days, 98 pounds, worth, at 5 cents, $4.90. Bran consumed was worth

$6.66, leaving a loss of $1.76, or it cost 6.9 cents to make one pound of gain.

Lot No. 2, weight May 5, 442 pounds, were fed same amount of polish that Lot No. 1 had of bran. May 15, weighed 594 pounds. June 23, weighed 656 pounds. Total gain in 29 days, 214 pounds, worth $10.70. Lot consumed 860 pounds of polish, worth $10.32, making a gain of 38 cents in 29 days. It cost 5 cents to make one pound of gain.

Lot No. 3, weight May 5, 460 pounds, were fed 15 pounds of polish and 5 pounds of molasses. May 15, weighed 510 pounds. May 15, polish was increased to 30 pounds and molasses to 10 pounds. May 21, weighed 580 pounds. Molasses was increased to 20 pounds per day. May 29, polish increased to 40 pounds per day. June 3, weighed 656 pounds. Total gain in weight, 29 days, 196 pounds, worth, at 5 cents, $9.80. Polish consumed, 450 pounds, worth $8.88. Molasses consumed, 260 pounds, worth $1.75. Total cost, $10.63, a loss of 83 cents. It cost 5.5 cents to make a pound of gain.

No doubt better gains would have been made had the weather been cooler. Our general observation has been that it is an easy matter to keep hogs growing satisfactorily through the summer, but they fatten more rapidly in cooler weather.

RICE POLISH VS. RICE POLISH AND RAPE PASTURE.

February 1, 1906, six pigs were put on an experiment; one group of three, weighing 330 pounds, were put in a pen and fed polish alone until March 5, and Nutraline from that date to March 23. The other group of three, weighing 370 pounds, were fed the same amount of same feed and allowed access to rape pasture. The two groups made the same number of pounds gain to March 23, when the experiment was closed, showing no advantage in this case in favor of the rape pasture.

This result seems extraordinary, as the pigs seemed to relish the rape, and the only explanation that can be suggested is that the individuality of the pigs was a factor. There should have been a larger number of animals on the experiment.

RICE POLISH (1907).

February 4 twelve pigs from six to eight months old that had had the run of fields and oats pasture during winter were put in a pen in good growing condition and fed what rice polish they would clean up twice daily. On February 4 the pigs weighed 962 pounds. On March 1 the pigs weighed 1,470 pounds, a gain of 508 pounds in 24 days, or a daily gain of 1.7 pounds per day per pig. Pigs ate 1,800 pounds of polish at $26.50 per ton at a cost of $23.85. Sold the pigs at 5 1-2 cents, or $80.85. 508 pounds of gain at 5 1-2 cents would be worth $27.94, leaving a profit of $4.09. The actual profits were more than this, as the pigs would not have brought 5 1-2 cents when the experiment was begun. It cost 4.6 cents to make one pound of pork.

DWARF ESSEX RAPE AND OATS COMPARED.

Dwarf Essex rape has a good reputation as a forage crop for hogs and sheep in the North. On rich land it makes an excellent growth in Louisiana, and, judging from the appearance of the crop, would afford more nutrients per acre than most any other winter forage.

In 1905 small, equal areas of rape and oats were planted and grazed by two pigs on each plot from December 10 to December 29, when the Essex rape was exhausted and the experiment had to be stopped, though the oats were apparently as good as at the beginning of the experiment.

The pigs on the oats gained .21 pounds per day per pig; those on the Essex rape gained .12 pounds per pig.

The same year a small area was planted in mixed oats and Dwarf Essex rape and pastured with hogs and cows to test their preference for the crops. Neither cows nor hogs would eat the Essex rape until the oats were grazed short, thus showing a decided preference for the oats.

On January 26, 1906, two pigs weighing 266 pounds were pastured on good rape until February 9, when the two weighed 268 pounds, having gained only two pounds in fourteen days, which is within the limit of error in weighing.

On January 26, 1906, four barrows weighing 440 pounds were put on rape and oats mixed. On March 23 these hogs weighed 486 pounds, or a gain of 46 pounds in fifty-six days. The rape was not eaten in the early part of the experiment, and not until the oats were grazed to the ground did they eat the rape. Forty-six pounds of pork at 5 1-4 cents would have brought $2.41. There was less than a third of an acre in the plot.

Experiments For 1908-09.

GRAZING OATS.

September 20, 1908, oats were planted for grazing with hogs on 1.76 acres. The land had been in sorghum previous to planting oats, producing about 12 tons per acre, which was put in the silo. Good rains were secured during the fall and winter and warm weather prevailed, consequently the oats did well and produced abundance of grazing.

On October 13 the hogs were weighed and put on the oats without other feed, and allowed to graze until December 9. The weights were as follows:

October 13, large sow weighed 180 pounds—December 9, weighed 222 pounds, a gain of..........	42 pounds
October 13, small sow weighed 156 pounds—December 9, weighed 196 pounds, a gain of..........	40 pounds
October 13, eleven pigs weighed 344 pounds—December 9, weighed 484 pounds, a gain of......	140 pounds
Total	222 pounds

The pigs gained at the rate of .22 pound per day for 57 days.

The sows gained at the rate of .71 pound per day for 57 days.

The sows were just weaning their pigs, consequently were in fine condition for gaining.

Cost of preparing the land and planting the oats:

One man and pair of mules, plowing and harrowing, two days at $3....................................	$6.00
Four bushels of seed oats at 75c........................	3.00
Total	$9.00

222 pounds' gain at 6 cents equals $13.32, leaving a profit of $4.32 after all expenses of planting were deducted.

The hogs could not keep this area grazed down, so on December 10 other hogs were added to the lot. It was also thought advisable to feed some in addition to the grazing. The lot was fed 24 pounds of a mixture composed of one pound of cotton seed meal and ten pounds of rice polish. The mixture cost $1.25 per hundred pounds.

December 9, large sow weighed 222 pounds; March 1, weighed 270 pounds, a gain of 48 pounds in 81 days.

December 9, small sow weighed 196 pounds; March 1, weighed 250 pounds, a gain of 54 pounds in 81 days.

December 9, eleven pigs weighed 484 pounds; March 1, weighed 928 pounds, a gain of 444 pounds in 81 days.

December 10, one male weighed 156 pounds; January 18, weighed 178 pounds, a gain of 22 pounds in 39 days.

December 10, two gilts weighed 292 pounds; December 24, weighed 340 pounds, a gain of 48 pounds in 14 days.

The total gain made was 616 pounds.

On this piece of land we could easily have pastured 15 head per acre. On January 18 there was perhaps some sign of cotton seed meal poisoning, so the feed was changed to equal parts of shorts and rice polish, which cost us $1.35 per hundred pounds.

During the period of 81 days we had fed $24.98 worth of feed, and the hogs had gained 616 pounds, worth 6 cents a pound, or $36.96, or $11.98 over and above the cost of the feed.

The experiment extended over a period of 138 days, in which time the hogs had eaten $24.98 of very high-priced feed, and had gained 838 pounds, worth 6 cents, or $50.28. To the price of feed might be added the cost of planting the oats—$9.00, bringing the cost to $33.98, or a cost of about 4 cents a pound.

After the hogs were taken off the oats produced 1.8 tons of good hay. The land was then planted in sweet potatoes for hog feed.

SWEET POTATOES FOR HOGS.

Sweet potatoes in the South are generally recognized as a valuable crop for hogs. In order to get something of this value as a feed, on July 11, 1906, four-tenths of an acre of good land was set out in sweet potatoes. In the fall a few rows were dug in order to estimate the yield, which were put at 320 bushels per acre. The variety was Southern Queen, a large, dry potato.

On November 17 twenty-one head of hogs, including sows and shoates, weighing 2,460 pounds, were given access to the potatoes from a Bermuda pasture. On December 6 the hogs had about eaten all the potatoes, and weighed 2,950 pounds, a gain of 490 pounds in nineteen days, or an average gain of 1.2 pounds per day per pig. Four hundred and ninety pounds of pork at 6 cents, the price of hogs at that time, would have brought $29.90. At this rate one acre of potatoes would have brought $73.50 worth of products. This rate of gain, however, would not have been maintained as the hogs became fatter. A portion of this gain also was ''fill up'' gain.

On November 9, 1909, 23 head of hogs were selected for grazing sweet potatoes. They weighed 2,520 pounds. This bunch was put on the potatoes and fed a little ear corn each day. The corn was charged at 50 cents a barrel, being the prevailing price at that time. On December 1 the bunch weighed 3,130 pounds and had gained 610 pounds in 22 days. This was a gain of 1.2 plus, each day. These hogs had eaten 4 1-2 barrels of corn at 50 cents, or $2.25 worth of corn. Had rooted 12 rows of potatoes 236 feet long, which would be about .24 of an acre.

On December 9 the bunch weighed 3,390 pounds and had gained 260 pounds in eight days, or 1.41 pounds each per day; had eaten 1 1-2 barrels of corn and rooted eight rows, or .16 acre, of potatoes.

On December 9 two of the smaller ones were taken out of the experiment and sold at 7 cents per pound, weighing 370 pounds. One pig, weighing 102 pounds, was put in at this time, making the lot weigh 3,112 pounds.

On December 9 we began feeding a mixture composed of 2 pounds of cotton seed meal and 5 pounds of rice polish. The mixture cost $28.42 per ton. Fed the lot 37 pounds of the mixture per day.

On December 23 the bunch weighed 3,480 pounds and had gained 368 pounds in 14 days, or 1.19 pounds each per day. These hogs ate 518 pounds of feed at $28.42 per ton, or $7.35 worth of feed, and had rooted 18 rows of potatoes.

On December 23 a Tamworth sow was put in, weighing 294 pounds, making the lot weigh 3,774 pounds. The bunch was fed 50 pounds of the above mixture per day.

On January 7 the bunch weighed 4,210 pounds, a gain of 436 pounds in 15 days, or a daily gain of 1.26 pounds. These hogs were fed 750 pounds of feed at $1.42 per 100 pounds, or $10.65 worth of feed. They rooted 30 rows of potatoes.

Hogs were sold at 7 cents per pound.

RECAPITULATION.

	Weight Pounds.	Average Weight Pounds.
Nov. 9—12 head of barrows	2,040	170
Nov. 9— 6 head of grade razor backs	360	60
Nov. 9— 1 sow and 4 pigs	120	24
Dec. 9— 1 pig	102	
Dec. 23— 1 Tamworth sow	294	
Total weight	2,916	

Weights at close of experiment:

	Pounds.
Dec. 9—Two barrows were taken out weighing	370
Jan. 7—Ten barrows were taken out weighing	2,830
Jan. 7—Seven razor backs were taken out weighing	910
Jan. 7—One sow and 4 pigs were taken out weighing	170
Jan. 7—One Tamworth sow was taken out weighing	300
Total	4,580

This experiment extended over a period of 59 days, in which the hogs gained 1,664 pounds, or an average daily gain of 1.23 pounds. If the sow and four pigs and the Tamworth sow were cut out of the average the rest of the bunch made an average gain of 1.61 pounds.

During this period these hogs were fed six barrels of corn worth $3.00, 1,268 pounds of mixed feed worth $18.00—a total of $21.00. They rooted 1.52 acres of potatoes. The potatoes were the second crop on the land.

1,664 pounds of gain at 7 cents	$116.48
Feed consumed	21.00
Gain over and above cost of production	$ 95.48

HOGS GRAZING SWEET POTATOES AND FED RICE POLISH AND COTTON SEED MEAL.

On November 16, 1908, fourteen rows of potatoes were dug and the yield of the field estimated. The estimated yield was 150 bushels per acre. The acreage consumed by hogs was 1.21 acres. Portable fence was used to restrain pigs, allowing access to new area three times during experiment.

November 16 fifteen head of hogs weighing 1,472 pounds were put in the potato patch and were fed rice polish and cotton seed meal, mixed in the proportion of two pounds cotton seed meal and five pounds polish.

December 4 fifteen hogs weighed 1,922 pounds, a gain of 450 pounds in eighteen days, or a daily gain of 1.6 pounds.

December 4 two gilts, weighing 292 pounds, were taken out, leaving thirteen head, weighing 1,630 pounds, and eight pigs, weighing 360 pounds, were put in. December 10 one sow and six pigs, weighing 412 pounds, were added.

December 12 the hogs weighed 2,604 pounds, a total gain of 652 pounds from the start. In this time the hogs had been fed 1,020 pounds of feed, worth $12.55; 652 pounds of pork at 6 cents equals $39.12, a gain of $26.57 over and above cost of concentrated food.

December 12 the hogs were divided into two lots for the purpose of feeding one lot on potatoes alone and the other on potatoes and rice polish and cotton seed meal. However, an error was made in weighing that was not discovered until too late to make correction, and, while the plan of feeding was carried out to December 30, only the total gain can be reliably considered. At the beginning of the last period a hernia pig was taken out weighing 45 pounds and another animal weighing 160 pounds was put in, making total weight 2,719 pounds on December 12, for new period. December 30 the total weight was 3,310 pounds, making a gain of 591 pounds in 18 days, worth at 6 cents, $35.46. They consumed during this period 650 pounds of feed worth $8.12, leaving $27.34 return on potatoes and profit. The total dry feed consumed was worth $20.67. The total gain by hogs was 1,243 pounds, worth $74.58, leaving as return for potatoes and profit $53.91, on 1.21 acres, or $44.55 per acre, or approximately 30 cents per bushel for the potatoes.

STOCK BEETS AND RUTABAGAS.

Stock beets, though extensively used in the other countries, have never been extensively grown as a source of feed in Louisiana. The experiment stations have grown a number of varieties for many years, and always found that good yields should be expected in rich land. On October 23, 1906, plantings were made of the leading varieties on very rich soil. The beets were large enough in February, 1907, to give heavy yields of excellent quality. Some of these beets that were allowed to grow until late in May and early June, 1907, when the larger individuals weighed from twenty to thirty pounds. The largest one weighed balanced the scales at thirty-two and one-half pounds.

Beets planted on November 25, 1906, were ready for feeding April 1, 1907. The following varieties were found to be most productive:

Mammoth Red, or Giant Long Red.
Giant Feeding Sugar.
Lane's Improved Sugar.
Golden Tankard.
Mangel Wurtzel.
White French Sugar.

Hogs, sheep and cattle are very fond of beets, after they have once eaten them. In our first year's experience there were no weights kept on the beets eaten by the stock, nor of the gains made, yet the hogs gained in flesh and looked thrifty and healthy. The last of the November planting was fed on July 15, 1907.

Ground producing thirty barrels of corn per acre was plowed with a disc plow the latter part of August and harrowed thoroughly. A few days after this the land was bedded into four-foot rows. The rows were made this width for convenience, as three-foot rows would have done equally as well so far as the beets were concerned. The seeds were planted on September 7, 1907. Where the seed drill was used an excellent stand was secured, but after planting a few rows, the seeder was broken and the rest of the seed were sown by hand. On this area poor stand was secured and to this is partly due the small yields on this land.

PIGS FED ON BEETS.

On April 4, 1908, nine pigs, averaging eighty pounds each, were put in a lot and fed beets alone until May 20, when the pigs weighed 890 pounds, a gain of 170 pounds in forty-five days. This is an average gain of .42 pounds per pig per day.

These pigs ate from eighteen to twenty pounds of beets per day. At this rate it would take the nine pigs eleven days to eat one ton of beets. At this rate of gain one ton of beets should produce 41.58 pounds of pork. With pork selling at 6 cents, this would make beets worth $2.49 per ton. This land produced twenty-eight tons of beets per acre. At this rate an acre of beets would be worth $69.72 for pig feed.

On May 29, 1909, we began feeding beets, throwing to the hogs all they would clean up during the morning.

On May 29, the bunch weighed 1,786 pounds. On June 24, they weighed 1,943 pounds, a gain of 157 pounds in 26 days, or a gain of .287 pounds per day per hog.

BEETS AND CORN MEAL AS A FEED.

On May 20, six barrels of slightly damaged corn meal was purchased at $2.00 per barrel and fed to some pigs to which beets were fed as above. On June 22, after feeding the meal with what beets the pigs would eat, the pigs weighed 1,220 pounds, or a gain of 1.14 pounds per day per pig, for a period of thirty days.

In this case the pigs ate approximately eight pounds of beets each per day. They ate $12.00 worth of meal and about one and one-fourth tons of beets. This gave 330 pounds of pork, worth six cents per pound, or $19.80.

CULTIVATION OF BEETS.

It is best to put the rows from three to four feet wide, so that a mule and cultivator can pass through the rows without disturbing the beets. After the land is thoroughly prepared and the fertilizer applied, the seeds are planted in the drill at the rate of five to eight pounds per acre, if all conditions are ideal, otherwise plant eight to twelve pounds. This can be done by hand, but a seed drill is much preferred, as it plants regularly and at an even depth, thereby securing a better stand with less seed. At the same time cultivation is made easier from the fact that the young plants are confined to a narrower space, which enables one to cultivate nearer the young plants than could otherwise be done.

If a heavy rain should occur before the seed are up, a light harrow should be run over the bed, to break the crust and to destroy the grass and weeds. Cultivation should be very rapid after the seeds are up and as soon as large enough they should be gone over with a hoe, taking out the grass and weeds and at the same time thinning the plants to a distance of eight or ten inches. Missing places may be transplanted successfully, if care is taken not to break the tap root of the plants, otherwise a short stubby beet is produced.

Beets at this Station have never been hurt seriously by the cold, but in a few cases the frost has scorched the leaves a little and checked the growth. For stock feeding, beets growing well up out of the ground are to be desired, as they are easier to pull, and less dirt clings to the beet, making it lighter to handle and cleaner to feed. Giant Long Red excels in these desirable characters.

STOCK CARROTS.

Stock carrots when planted on the same land will mature several weeks earlier than the beets. Carrots should be planted and worked as beets, but should be left much thicker in the drill. When left three or four inches apart and even thicker, they produced fifteen tons of good nutritious feed per acre, and should be more generally planted. Stock carrots will stand much colder weather than beets without injury, but after maturing they go to seed, consequently have to be fed early or they deteriorate in feeding value.

The following varieties are recommended:

Large White Belgian,
Victoria, and
Long Orange.

CARROTS AS A FEED.

On May 3 a group of hogs were put on Bermuda grass pasture and fed what carrots they would eat until May 29. May 3 the group weighed 1472 pounds. May 29, they weighed 1786 pounds, a gain of 314 pounds in 26 days, or at a rate of .57 pounds each per day.

TURNIPS AND RUTABAGAS.

On September 7, 1907, varieties of turnips, rutabagas and carrots were planted. These are not as productive, nor as nutritious as beets, but the fact that they mature much earlier and only occupy the land for a short time, producing an abundance of good feed at a time when good, succulent feed is apt to be scarce, should recommend them for consideration. The earlier varieties of turnips are ready to feed in sixty days after planting, and will produce from ten to fifteen tons per acre on good land. They make fairly good cow feed, sheep are very fond of them and hogs will eat them. Planted in September they would give a quantity of feed in November and December.

The following varieties are good:
For early use, Red Top Strap Leaf,
Champion Purple Top,
Purple Top Globe,
Yellow Abberdeen (a late variety and a good keeper.)

Rutabagas should be planted and worked as beets. They are later in maturing, more productive and better keepers than the ordinary turnip. When planted in September, they should do to feed in December, January and February, and produce from fifteen to twenty tons per acre.

In the old country they are generally used for sheep food, allowing the sheep to do their own harvesting, being confined to small areas by portable fencing. They are also good for cattle, especially for dairy cows, if not fed in excess so as to impart a turnip flavor to the milk. When turnips are run through a cutter and sliced in small pieces, they are greedily eaten. Hogs will eat them, but they are perhaps less desirable for hogs than for cattle and sheep.

FEEDING SORGHUM TO PIGS.

On June 24 a group of hogs weighed 1943 pounds. On July 28, weighed 1944 pounds. In this case the hogs had all the sorghum they could chew for 34 days and gained one pound.

From July 28 to September the hogs were held on a maintenance ration and were fed sorghum, corn, cushaws and peanuts. Early in September the above hogs were put on peanuts, where there was about two-thirds of a stand. The hogs gained at the rate of 320 pounds per acre. After rooting the nuts there was another period from October 13 to November 9 when the hogs were allowed to root a few rows of potatoes and were fed some corn and at the same time allowed to run on an oat patch in order to hold them at their weight, as the potatoes were not sufficiently matured to turn the hogs on them. These hogs were then used in the experiment previously outline in grazing potatoes.

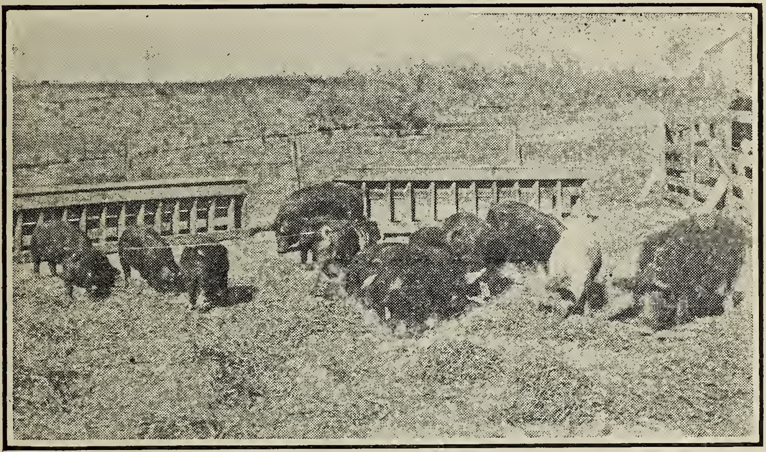
Louisiana Bulletin No. 124. November, 1910.

Agricultural Experiment Station

OF THE

Louisiana State University
and A. & M. College,

BATON ROUGE.



HOGS ON STATE EXPERIMENT STATION.

PART I. BREEDS OF HOGS

BY

W. H. DALRYMPLE

PART II. THE BEST CROPS TO GROW FOR HOGS, AND OTHER DATA

BY

W. R. DODSON AND S. E. McCLENDON

RAMIRES & JONES
Baton Rouge, Louisiana
1910

AGRIC. ECON. LIBRARY
LOUISIANA STATE UNIVERSITY

Louisiana State University and A. & M. College

Louisiana State Board of Agriculture and Immigration

EX-OFFICIO.

GOVERNOR JARED Y. SANDERS, *President.*
HENRY L. FUQUA, *Vice-President of Board of Supervisors.*
CHAS. SCHULER, *Commissioner of Agriculture and Immigration.*
THOMAS D. BOYD, *President State University.*
W. R. DODSON, *Director Experiment Stations.*

MEMBERS.

R. S. MOORE, St. Bernard.
HENRY GERAC, Lafayette.
JOHN T. COLE, Monroe.
JOHN J. HENDERSON, Lagan.
R. E. THOMPSON, Wilson.
JEFF D. MARKS, Crowley.
J. E. BULLARD, Belmont.

STATION STAFF.

W. R. DODSON, A. B., B. S., Director, Baton Rouge.
HAMILTON P. AGEE, B. S., Assistant Director, Audubon Park, New Orleans.
S. E. McCLENDON, B. S., Assistant Director, Calhoun.
FRIEND C. QUEREAU, M. S., Ass't Director, Rice Exp. Station, Crowley.
W. E. CROSS, Chemist, Audubon Park, New Orleans.
W. G. TAGGART, B. S., Assistant Chemist, Audubon Park, New Orleans.
R. E. GRAHAM, B. S., Assistant Chemist, Audubon Park, New Orleans.
WM. G. OWEN, B. S., Bacteriologist, Audubon Park, New Orleans.
J. K. McHUGH, Secretary and Stenographer, Audubon Park, New Orleans.
J. E. HALLIGAN, B. S., Chemist, Baton Rouge.
A. P. KERR, M. S., Assistant Chemist, Baton Rouge.
R. BAUS, B. S., Assistant Chemist, Baton Rouge.
R. G. FULLER, B. S., Assistant Chemist, Baton Rouge.
R. G. TILLERY, M. S., Assistant Chemist, Baton Rouge.
P. H. DOHERTY, B. S., Assistant Chemist, Baton Rouge.
G. D. CAIN, B. S., Assistant Chemist, Baton Rouge.
ROGER P. SWIRE, Treasurer, Baton Rouge.
J. B. GARRETT, B. S., Entomologist, Baton Rouge.
G. L. TIEBOUT, B. S., Horticulturist, Baton Rouge.
W. H. DALRYMPLE, M. R. C. V. S., Veterinarian, Baton Rouge.
C. W. EDGERTON, Ph. D., Plant Pathologist, Baton Rouge.
E. W. KERR, M. E., Professor Mechanical Engineering, Baton Rouge.
H. A. NADLER, B. S., Assistant Mechanical Engineering, Baton Rouge.
J. T. TANNER, B. A., Secretary and Stenographer, Baton Rouge.
WALTER McCLENDON, Farm Manager, Baton Rouge.
EWELL CAMP, Mailing Secretary, Baton Rouge.
IVY WATSON, Farm Manager, Calhoun.
E. J. WATSON, Horticulturist, Calhoun.
HENRY STAPLES, in charge of Dairy, Baton Rouge.
T. J. WEAVER, Gardener, Baton Rouge.

INTRODUCTORY.

The purpose of this bulletin is to afford information to the farmers of the State concerning different breeds of hogs, and the crops on which they may be profitably raised.

Since the advent of the cotton boll weevil, and the barrier it has placed upon the successful growing of cotton as a single crop, our farmers have become more and more impressed, not only with the greater importance of diversification of crops, but also with the value of more and better live stock of different kinds. And, while inquiries have come to the Experiment Station for information regarding all varieties of farm animals, much more has been sought about hogs, and their food crops, than any of the others.

It is with the purpose, therefore, of giving a brief, but more or less accurate description of the different breeds of hogs, and the crops that our State is capable of raising to feed them on, and of endeavoring, in this way, to encourage the industry, to which our State is so admirably adapted, that the publication of this bulletin has been undertaken at the present time.

PART I. BREEDS OF HOGS.

By W. H. Dalrymple.

Without going back into the ancestry of the modern hog, it might be mentioned that, in Great Britain, where the stock from which the majority of our present breeds originated, it seems to have been the custom to divide their hogs into white and black breeds; and these, again, into large, middle, and small breeds.

Another division is into types, viz., the lard and the bacon types.

For the purposes of this bulletin, however, it may suffice to consider the hogs under color conditions, giving the particulars concerning each breed as we come to it.

BLACK HOGS.

THE POLAND-CHINA.

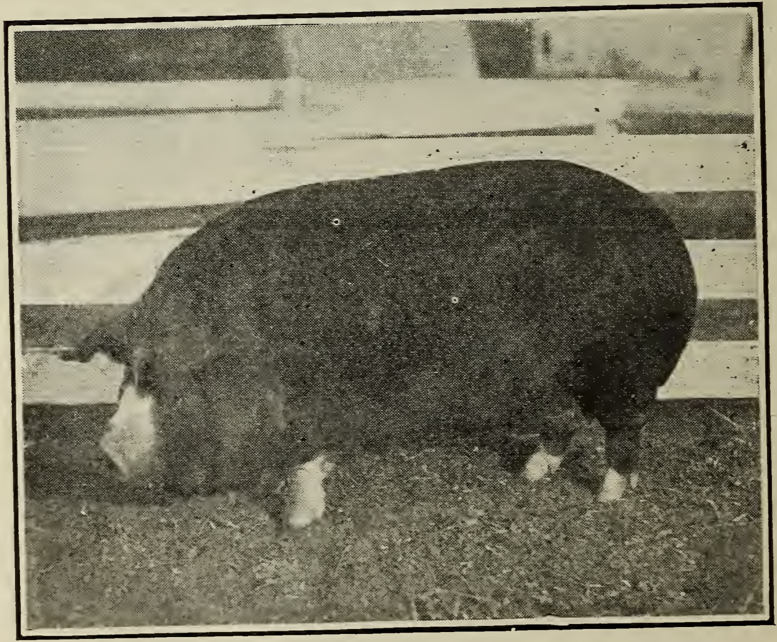
This breed is said to have originated in Southwestern Ohio.

DESCRIPTION AND CHARACTERISTICS.

Color—Black, with six white points, viz., feet, face, and tip of tail. The *face* is straight or very slightly dished, and the *ears* lop over about one-fourth to one-third from the tip.

A high quality specimen of the breed should be smooth throughout, with thick, broad, heavy *sides*, smooth *shoulders*, broad, heavy, plump *hams* extending well down to the hocks, with short legs and upright pasterns.

The *bone* is fine; the *tail* fine; the *head* and *ears* neat and attractive, and the *quality of the meat* is very good.



POLAND-CHINA.

The breed is characterized by *early maturing qualities*, and nearly perfect form of the *lard type* of hog, being blocky and compact.

The Poland-China seems to adapt itself to any conditions that furnish plenty of food for the production of quick growth; but also to a range of conditions comparable with other breeds.

The breed is admirable for crossing on common stock for grading purposes, and has been successfully used in different sections of Louisiana for a number of years.

Poland-China pigs, fed for market, may be made to weigh 200 pounds, or over, at six months of age. At one year old, males should weigh about 300 pounds, and sows, 250 to 275 pounds. While, in *breeding form,* at full maturity, males should readily weigh 500 pounds, and sows, 400 pounds.

The large type of Poland-China has more size; the flesh is coarser grained, and not as good in quality.

The *breeding qualities* of the Poland-China are considered fair.

THE BERKSHIRE.

This breed is of English origin, as the name would indicate, and is said to have been first brought to this country about 1830.

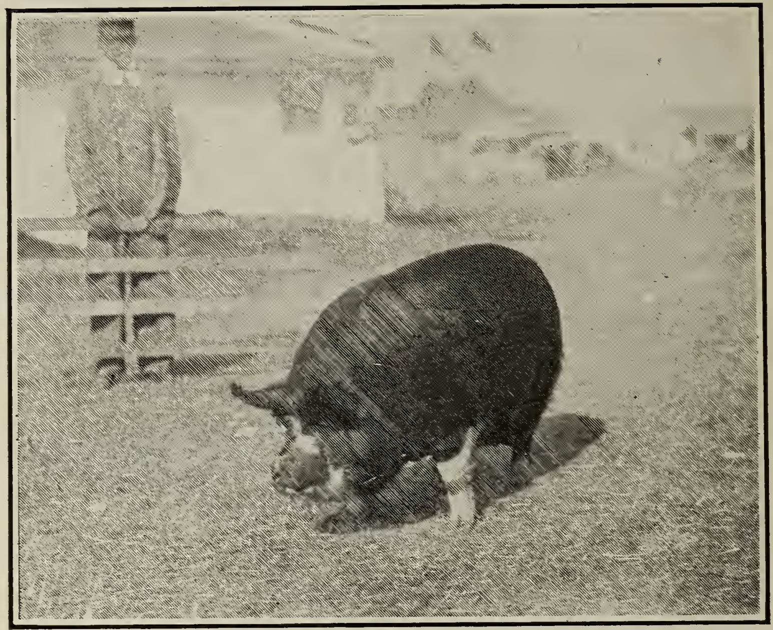
Description and Characteristics.

Color—Black, and, like the Poland-China, has six white points, viz., on feet, face, and tip of tail. The *face* is short to medium in length, and gracefully dished, and the *ears* are erect, or slightly inclined forward. The *back* is level and of moderate breadth, with considerable length of side. The *cheek,* or *jowl,* is full; the *shoulder* of medium thickness and breadth; the *ham* is deep and thick, extending well up to the body and down to the hock; the *leg* is medium to short, straight and strong, and widely set apart. The *bone* is of fair quality.

Although the Berkshire is classed as belonging to the fat or lard type, it is generally considered as a *medium* between the lard and the bacon types of swine.

The breed seems to be able to adapt itself to almost any environment, as it is found being successfully raised in the warmer sections of the South and Southwest, as well as in the more northerly parts of the country.

The *early-maturing qualities* of the Berkshire are classed as good; and as a *grazer,* it ranks high.



BERKSHIRE.

Pigs at six months old should readily weigh 175 pounds, and at one year old, about 300 pounds. In *breeding condition,* mature males should weigh about 500 pounds, and sows, 400 pounds.

For *grading purposes,* the value of the Berkshire male on common stock is undoubted. And where fair individuals of pure breeding are used, the Berkshire crosses well with the Poland-China, and other breeds.

The merits of this breed are already fairly well known throughout the State.

In general, the Berkshire is not lacking in *fecundity.*

THE ESSEX.

The native home of this breed is the county of Essex, England.

DESCRIPTION AND CHARACTERISTICS.

Color—Entirely black. The *head* is fine, rather short, with slightly dished *face;* the *ears* are thin and erect; the *jowl* is heavy and the *legs* are short and firmly boned. The *back* is broad and somewhat short, and the *sides* are deep and short. The *shoulders* are thickly fleshed, and the *hams* thick and deep.

The Essex is a small, compact, chunky hog on short legs. It is typical of the *lard type* of hog, except that it is small in size.

The breed is noteworthy for *early maturing qualities*—feeders maturing at six months of age.

As compared with the Poland-China and Berkshire, the Essex ranks among the smaller breeds. At maturity it is said to attain a weight of from 250 to 400 pounds, depending upon the care and treatment.

ESSEX.

The *quality of the meat* is fine and well-flavored, with a tendency to fat over lean.

The *crosses and grades* may be of considerable comparative value. According to an English breeder, "There is probably no black pig which combines more good qualities as either porker or bacon hog than the produce of an improved Essex boar and an improved Berkshire sow."

The place for the Essex seems to be in the hands of the small breeder or feeder.

The Essex is not *perhaps so prolific* as some of the other breeds, but it cannot be looked upon as a shy breeder.

THE HAMPSHIRE OR THIN RIND HOG.

Originally this hog came from Hampshire, England, but in its present state of development, it may be said to be an American breed.

Description and Characteristics.

Color—Black, with a white band, four to twelve inches wide, encircling the body, and including the fore legs.

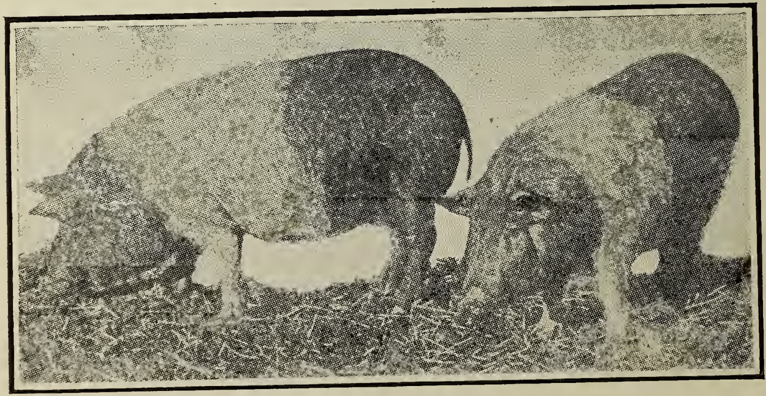
The *head* is small; the *ears* of medium length, inclining slightly forward. The *jowls,* or *cheeks,* are light; *back* of medium width. The *hams* are somewhat lacking in fullness compared with the larger American breeds; the *legs* are well set apart.

This breed is sometimes classed as a *medium* between the lard hog and the bacon hog, although it is generally considered as belonging to the former. It is, however, about medium in size.

A *cross* of the pure-bred male on common sows is thought likely to result in more prolific stock, leaning toward the bacon type.

The Hampshire is a good *grazer* and is *quite prolific.*

The *quality of the meat* is superior.



HAMPSHIRE OR THIN-RIND HOG.
(Plumb's "Types and Breeds of Farm Animals.")

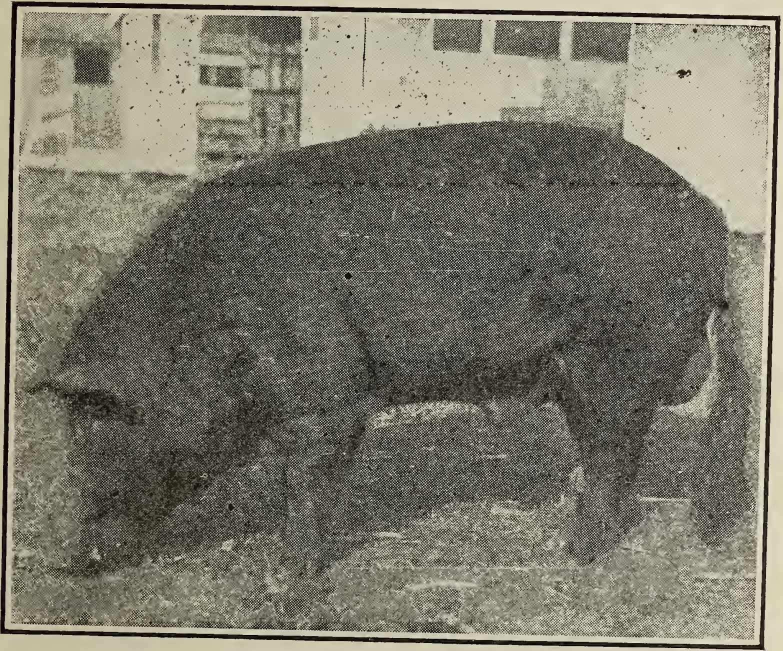
RED OR SANDY HOGS.

THE TAMWORTH.

This is the extreme of the English bacon type of hog, and is one of the oldest and purest of British breeds.

DESCRIPTION AND CHARACTERISTICS.

Color—Red, or sandy, varying in shade from light to dark. Large in form; lean in type; and long in head, body and leg.



TAMWORTH.

The *snout* is long and tends to be straight, and the *face* is but slightly dished. The *ears* are large, and should be erect, or leaning slightly forward, and not breaking over. The *back* is narrow and long, and the *sides* long, and should be deep. The *shoulders* and *hams* represent the lean type.

The Tamworth is distinctly a *bacon type* of hog, and as such, ranks very high.

This breed is large in *size*, and can be made to weigh from 700 to 900 pounds, and even more. The average mature male will probably weigh about 600 pounds, and the sow, 450 pounds. At six months of age, pigs will weigh about 175 pounds.

The *early-maturing quality* of this breed is said to be inferior, but the *feeding quality* fairly good.

A favorite *cross* with some of the English feeders is between the Tamworth male and the Berkshire sow. One authority claims that Tamworth males bred on the fat type of American sows, should produce a very attractive, easy-feeding, highly-marketable porker.

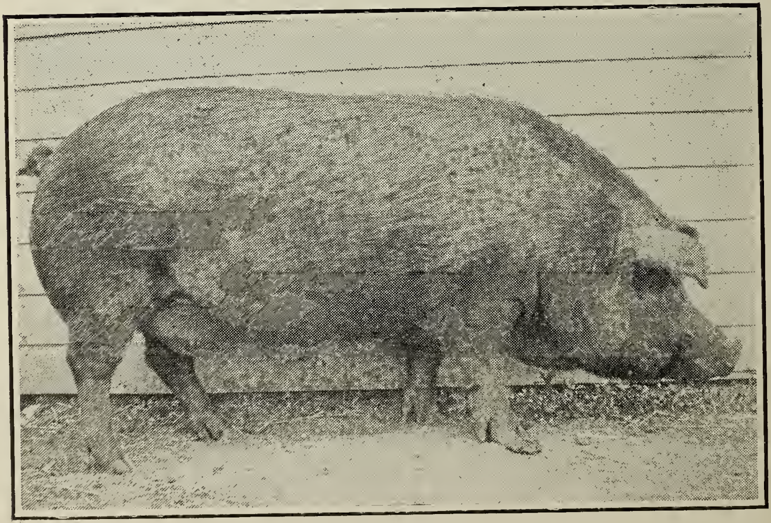
The Tamworth is *strikingly prolific*, and the males very prepotent. The breed has *good grazing* or *rustling qualities.*

THE DUROC-JERSEY.

The Duroc-Jersey is an American breed of swine, and in its latest improved state, is quite a modern hog. It is represented by some writers as originating in the Tamworth, the Red Berkshire, and the African or Guinea hog.

Description and Characteristics.

Color—Red or sandy, although the shades vary from light to dark. The *body* is rather short, with *legs* of medium length, and well-placed feet. The *head* is considered small in proportion to the size of the animal. The *face* is either straight, or



DUROC-JERSEY.
(Courtesy of Prof. Dietrich, Ill.)

slightly dished, and the *nose* is of medium length. The *ears* are of medium size, drooping forward, and the top third more or less breaking over. The *back* is of considerable width in contrast to length. The *body* often shows unusual depth. The *shoulders* and *hams* are rather heavy and thick fleshed.

In form of body, the modern Duroc-Jersey resembles the Poland-China more than the Berkshire.

This hog is classed among those of the *lard type.*

The *maturing qualities* of the breed are considered high class.

Pigs readily mature at six months old to dress out 175 pounds.

As to *feeding qualities,* the Duroc-Jersey classes with the Poland-China and Berkshire; and as a *grazer,* it seems suited to conditions favorable to other breeds.

The *quality of the meat* is regarded as good, compared with the Poland-China, when the same kind of food is used.

Pigs from common sows sired by Duroc-Jersey males, feed well, and when mated with Poland-China blood, are said to produce increased size of litters.

The *breeding* characteristics of this hog are considered distinctly superior.

The points of excellence in favor of the Duroc-Jersey are its *hardiness, growthiness,* and *prolificacy.* In the warm climate of the South, this hog has recently met with great favor, as it does not seem to be unfavorably affected by the dry, warm summers, especially as regards skin troubles, which the writer is inclined to believe is somewhat due to its color.

WHITE HOGS.

THE YORKSHIRE.

This is an old English white breed of hogs. Its blood is said to have entered into the formation of practically all breeds, either of English or American origin.

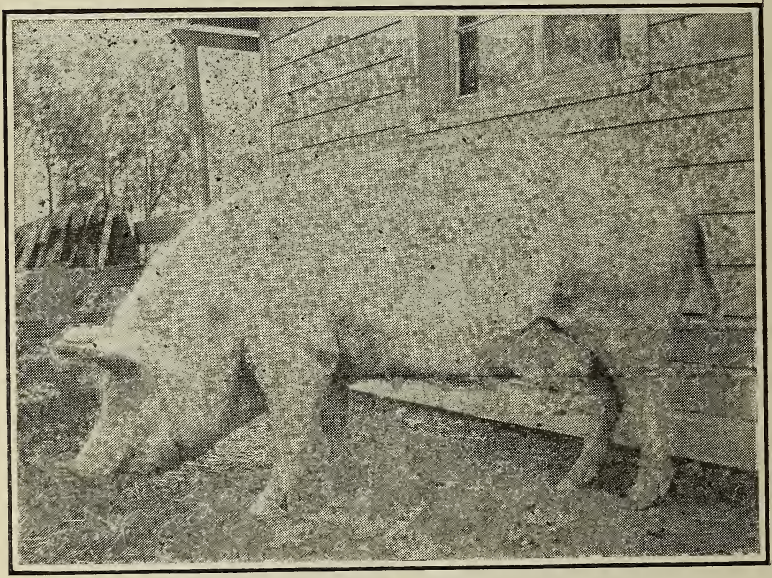
There are three different varieties of the Yorkshire, viz., the Large, Middle or Medium, and Small. The Large Yorkshire is a *bacon hog,* while the Small Yorkshire is of the *fat or lard type,* and the Middle Yorkshire is a *medium* between the two.

THE LARGE YORKSHIRE.

DESCRIPTION AND CHARACTERISTICS.

Color—White. The *head* is medium in length, with but little upturned curve; the underjaw is broad and strong; the *ears* incline to be heavy and droop forward. They should be fine, of medium size and be carried well upward and only slightly pointing forward.

The *body* should have considerable length; the *back* should be of fair and uniform width with considerable depth, the *sides* being long and deep at the flanks, and full between shoulder and hip.



LARGE YORKSHIRE.

(*Courtesy of Prof. Dietrich, Ill.*)

The *hams,* although not extremely fat and heavy, should be of good size and thickness, with the thighs well carried down.

In *size,* the Large Yorkshire stands in the first rank. Sows of this breed have been known to weigh considerably over 1,000 pounds.

The *early maturing qualities* of this breed are not pronounced.

Cross-breeds of this breed are of very superior type, especially from our typical American sows. As a *bacon producer,* this hog ranks high; and as a *breeder,* it takes a first place. Its *feeding qualities* do not seem to have given perfect satisfaction in this country; neither does the pure-bred *graze* equally well with our more common breeds.

THE MIDDLE YORKSHIRE.

Color—White. This hog is said to be the outcome of the cross between the Large and the Small Yorkshire. It is of smaller and *fatter type* than the Large White. Its *face* is more dished, its *back* is broader, and it more nearly approaches American ideals of form. The Middle Yorkshire is not a recognized breed in America, although it is in Great Britain.

MIDDLE YORKSHIRE.

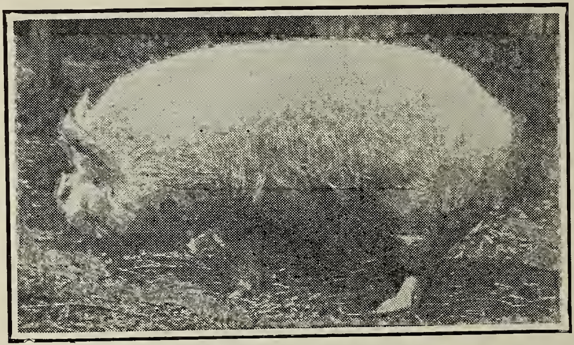
THE SMALL YORKSHIRE.

The origin of this, the smallest of the Yorkshires, is, in England, obscure. It is assumed to have come from Chinese stock, although different today from the early Chinese type.

Description and Characteristics.

Color—White, except for occasional black spots.

The *face* is very short and broad, and often dished to such an extent as to point the end of the nose upward. The lower jaw, also, is much curved upward; the *ears* are short, fine and erect, and pointing forward; the *jowl* is very round and highly developed.



SMALL YORKSHIRE.
(*Plumb's "Types and Breeds of Farm Animals."*)

The *back* is very broad, short, and thickly laid with flesh or fat.

The *hams* and *shoulders* are heavy and full, and the *bone, hair,* and *quality* are refined.

The breed ranks as the smallest in this country, but it has great breadth and depth for its size.

The matured pig will weigh about from 180 to 200 pounds, although they have been made to weigh nearly 300 pounds at 15 months of age.

The *early maturing qualities* of this breed rank very high; they *fatten* readily, and are said to be good *grazers.*

The *quality of the meat* is good, but it contains a high percentage of fat.

To obtain good results from *crossing,* the Small Yorkshire should be mated to animals of the larger breeds.

As *breeders,* they rank as medium, with a tendency to small litters.

THE CHESTER WHITE.

The original stock of this breed was imported from England, but the breed itself originated in Chester County, Pennsylvania.

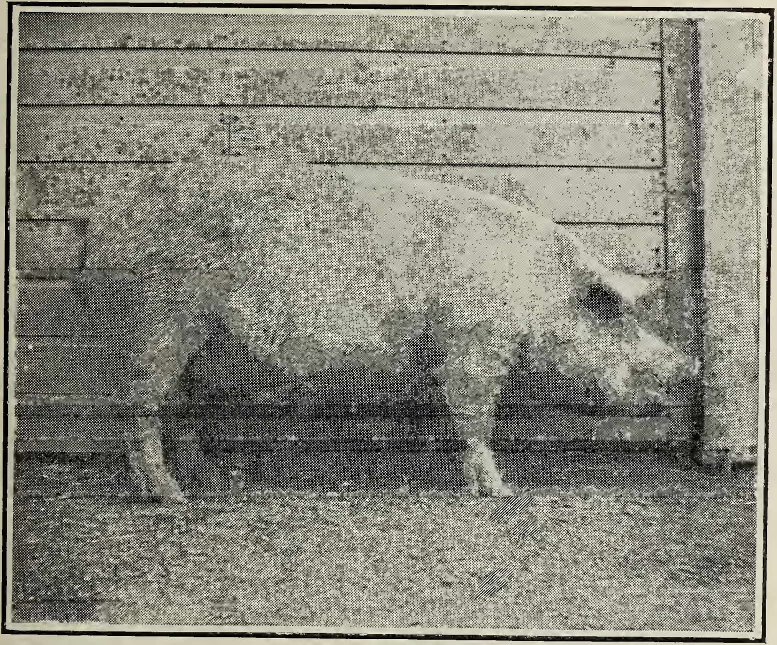
DESCRIPTION AND CHARACTERISTICS.

Color—White, with occasional black, or bluish-black spots on the skin.

The *size* ranges from a large hog to one of medium size.

The Chester White belongs strictly to the *fat or lard type*, producing a relatively large proportion of fat meat to lean in the carcass.

The *face* is straight, with the *nose* tending to be long and narrow, and the *ears* are drooped forward, breaking over from one-half to one-third of their length.



CHESTER WHITE.
(Courtesy of Prof. Dietrich, Ill.)

The *body* is blocky in form, although not very long. with heavy *hams* and smooth *shoulders;* broad *back,* and smooth throughout.

Mature males in fair flesh will weigh about 600 pounds, and sows about 450 pounds; while barrows at 6 to 8 months old should feed to weigh 350 pounds.

As a *feeder,* the Chester White ranks high; and is considered one of the most *prolific* of the heavier-fleshed types.

As a *grazer,* this hog will do well on good pasture, and compares favorably with other breeds.

Cross-bred and grade Chester Whites make excellent feeders.

The *quality of the meat* ranks as good.

On account of their color, they, like other white-skinned breeds, are liable to sun-scald, and other skin troubles, from the hot sun in our Southern climate.

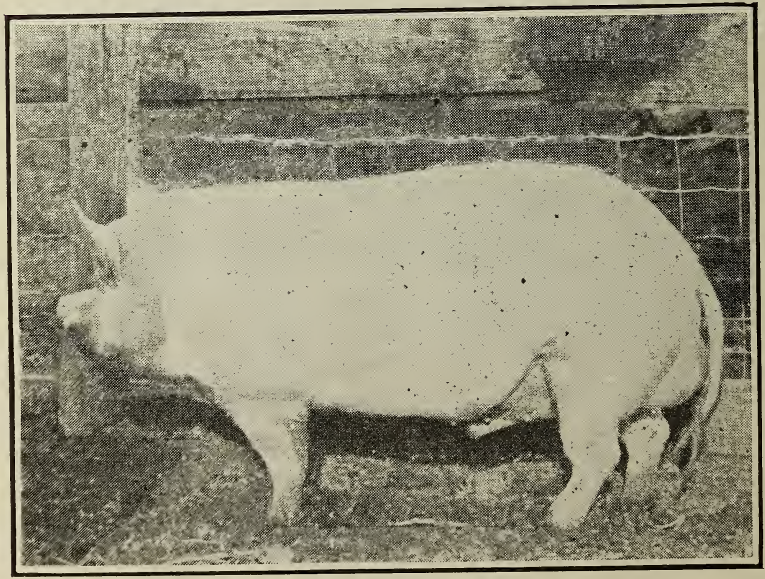
THE CHESHIRE.

The native home of the Cheshire is Jefferson County, New York State. It is the outcome of crosses between the Large Improved Yorkshire and Suffolk breeds upon native white hogs.

DESCRIPTION AND CHARACTERISTICS.

Color—White. The *face* is somewhat dished, although not extremely so; the *ears* are small and fine, stand erect or point slightly forward.

The *back* should be long, broad and straight nearly to the



CHESHIRE.
(Courtesy of Prof. Dietrich, Ill.)

root of the tail. The *body* as a whole has considerable length, but frequently lacks depth.

The *hams* and *shoulders* are regarded as thick-fleshed and well-developed; the *leg bones* show considerable refinement.

The *size* of the Cheshire is about medium, and as a breed, closely resembles the Middle Yorkshire in form.

The *quality of the meat* ranks high.

Cross-bred and grade Cheshires are not very common, but are looked upon with favor in some localities.

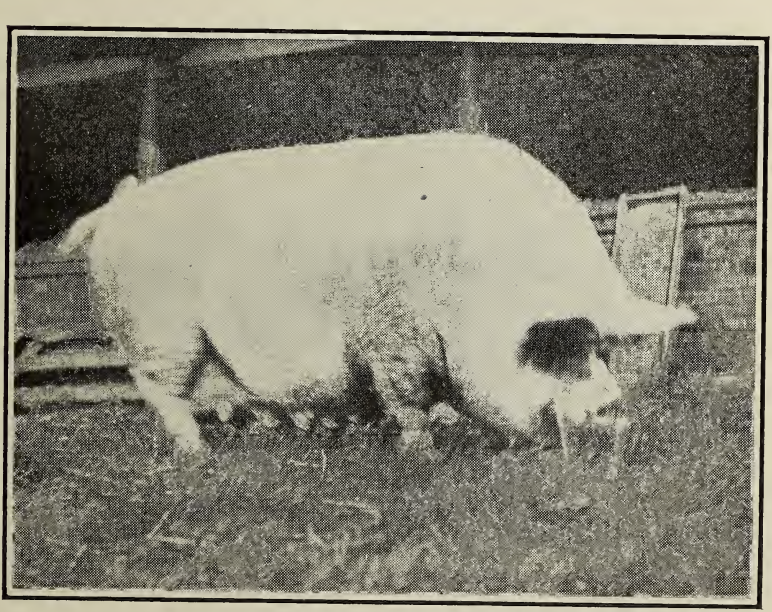
As a *feeder and grazer,* the qualities of this breed are not as yet very well known.

The *breeding qualities* of the Cheshire are above medium.

The popularity of this breed is largely local, it being one of the least known breeds in the country.

THE VICTORIA.

The origin of this breed of hogs is accredited to two sources, which has resulted in the Davis Victoria and the Curtis Victoria, the former an Indiana product, and the latter produced in New York State.



VICTORIA.
(*Courtesy of Prof. Plumb, Ohio.*)

Description and Characteristics.

Color—White. The *head* is moderately broad; the *face* medium dished; the *ear* small to medium in size, and carried erect.

The *body* is broad and deep; the *back* level, and the *tail* set on at a line nearly level with the back.

The *hams* and *shoulders* are considerably thick and full, and the length and depth of *side meat* is very good. The length of *leg* is moderate, and the quality of *bone* is fair. In form, this hog somewhat resembles the Middle White Yorkshire.

In *size*, the Cheshire ranks as medium with the Poland-China and Berkshire. At maturity, the males should weigh about 600 pounds, and the sows 450 pounds.

As a *feeder*, this breed has not been extensively tried, as its distribution has been limited chiefly to Indiana, Ohio, and Illinois, although herds are found in some other Mississippi Valley states.

The *quality of the meat* will rank well among that of other breeds.

The *cross-bred or grade* Victoria has not been extensively tried, and its value is not commonly known.

The *breeding qualities* of this hog are considered very good.

THE COMMON SOUTHERN HOG.

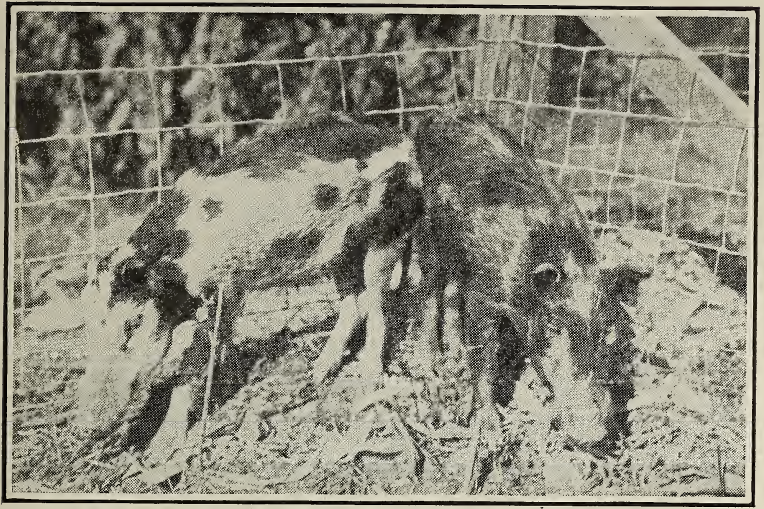
THE "RAZORBACK."

The hog which we in the South know as the "Razorback" is a representative of the unimproved breed in this country, and is confined, almost entirely, to the more southern states.

Description and Characteristics.

Color—Varied. As a breed the Razorback is a *long-bodied, long-legged, thin, long-nosed* hog, exceedingly *hardy* and with remarkably *good foraging powers*, but *too slow in coming to maturity*, and *too light in weight* to compare with the modern and improved breeds of swine. In describing this breed of hogs, a writer adds: "It has no place in modern agriculture."

If we consider the Razorback from the standpoint of a breed, only, we fully agree with the writer just quoted. But this hog is susceptible to much improvement through an intelligent



THE "RAZORBACK."

system of grading by the use of males of improved breeding, and especially of the larger kinds, on the best of the native females. In this State, the "woods are full" of razorbacks, and, although they "have no place in modern agriculture," our problem is how to get rid of them, and at the same time make the most out of them. In suggesting methods of improvement in all varieties of our native live stock, the writer has always recommended the grading-up process by the use of pure-bred males; and in the case of our hogs, we have the same advice to offer. The first step should be the conversion of all native male pigs into barrows. The second should be the selection of the best of the young native sows for breeding purposes. And the third should be the purchase and use of pure-bred males of whichever breed and type the owner prefers. In a few generations of judicious selection and grading, we would be able to bring our native hogs up to a class that would be more profitable, and that would find a ready market at a much younger age than at present obtains. Except in the case of those who desire to go into the business of breeding and raising pure-bred hogs for sale, it is unreasonable to expect that the ordinary raiser of swine can afford to purchase all pure-bred animals.

It is too expensive a proposition. But, in his native sows, he has already got the basis for improvement; and if he will only carefully select these, and use pure-bred males of the improved types, it will only be a matter of a few generations of grading-up before he has a class of hogs that the best markets will be very glad to secure. This seems the most intelligent and rational way of "getting rid" of our Razorbacks, which the writer quoted says, "have no place in modern agriculture."

AS TO THE "BEST" BREED OF HOGS FOR THE FARMER.

The question is often asked, "What is the best breed of hogs?" In answering this question, it may be said there is no one breed of hogs that is "best" for every farmer. That which is best for one may not be best for another. In a general way, the "best" hog is the one the farmer likes, provided it is what his market demands. Should his market want a hog of the bacon type, then one or other of the breeds of that type would be best in his case. On the other hand, should the most marketable be a fat, or lard, hog, then the most profitable animal for him to raise would be one or other of the lard types.

This is a matter which the farmer will have to decide for himself.

After the farmer has decided upon the breed of hogs which he believes to be the best and most profitable for him to raise, however, he should then stick to that breed and endeavor to develop it to its most perfect condition.

There has been a tendency, up to the present, to change breeds frequently, and upon the slightest suggestion, whether with apparent reason or otherwise, before adequately determining the suitability of each as to the needs of the farmer, or the requirements of his market. This is to be deprecated, as it is not possible to get the most out of a breed by continually changing from one to another.

The most famous individuals, and the most famous herds of animals, have been built up, developed and perfected, only by sticking to the breed and getting the most out of it.

There is plenty of room, and sale, for all the different breeds of hogs; but it is useless for one individual to try to raise, and bring to their most perfect development, all of them.

In the opinion of the writer, there will be an increasing demand in the State for pure-bred hogs, of all kinds, for breeding and grading purposes; and those who make a specialty, each of his own particular breed, will reap the benefit of increased prices for animals of the highest excellence.

STATE REGULATION CONCERNING THE IMPORTATION OF HOGS.

In order to protect the hog industry in the State by preventing diseases being introduced through imported animals, the Louisiana State Live Stock Sanitary Board has a regulation bearing upon this subject, which we here quote as a matter of information, and to prevent possible inconvenience, to prospective purchasers of hogs in states outside of the State of Louisiana:

Regulation 5 (of the Louisiana State Live Stock Sanitary Board)—"All live stock, when brought into the State of Louisiana by any person, persons, firm, corporation, railroad, or other transportation company, shall be accompanied by a certificate of health, and said certificate of health shall state that said animal or animals is, or are, free from infectious, contagious, or communicable disease. Said certificate must be made by a qualified veterinarian immediately after he has personally examined the live stock, and within twenty-four hours before the live stock have been shipped into the State of Louisiana. Said certificate shall be attached to and accompany the shipping bill of the live stock to the place to which the live stock are shipped, and the owner of the live stock, or the agent of the transportation company, shall mail or send such certificate to the Secretary and Executive Officer of the Louisiana State Live Stock Sanitary Board, at Baton Rouge, immediately following the arrival of the live stock at its place of destination; provided, that the provisions of this regulation are not intended to apply to live stock which are to be used for immediate slaughter, but which must be free from all infectious, contagious, or communicable diseases."

Notwithstanding the above regulation to prevent the importation of diseased animals into the State, it is earnestly recommended, as a further precaution against hog-cholera, that all hogs purchased in other States, or, in fact, anywhere outside of the purchaser's own premises, be strictly quarantined, after their arrival, for at least two weeks before being placed with the herd, and that they be sprinkled, twice a week, or so, with a 2 or 3 per cent solution of any of the standard coal-tar dips, and the quarters kept thoroughly disinfected.

The purpose of the above recommendation is to allow time for the cholera to develop while the animal, or animals, is in quarantine, should the disease be present in latent form, and thus prevent its transmission to the herd, which in many cases might readily occur in the absence of the precaution mentioned.

It might be stated, also, that the above mentioned solution will be found useful for sprinkling or dipping pigs infested with lice.

In compiling the information with regard to the different breeds of hogs, the following authorities have been consulted and quoted:

"Types and Breeds of Farm Animals" (Plumb).
"Farmer's Cyclopedia of Live Stock" (Wilcox & Smith).
"The Study of Breeds" (Shaw).
"Swine" (Dietrich).
"Live Stock of the Farm" (Pringle).
"The Live Stock of the Farm" (Edited by J. Chalmers Morton).

A USEFUL MIXTURE FOR HOGS.

Take

6 bushels of corn-cob charcoal, or,
3 bushels of common charcoal,
8 pounds of common salt,
2 quarts of air-slacked lime, and
1 bushel of wood ashes.

Break the charcoal well down, with shovel or other implement, and thoroughly mix all of the ingredients together. Then take 1¼ pounds of copperas (sulphate of iron), dissolve it in hot water, and with an ordinary sprinkling can, sprinkle the solution over the entire mass, and again thoroughly mix. Put the mixture in self-feeding boxes, or boxes protected from the weather, and place them where hogs of all ages may eat of their contents at pleasure.

Quantities, either greater or smaller than that given, may be prepared by simply observing the proportions of the different ingredients.

HOG CHOLERA SERUM.

All inquiries regarding hog cholera serum should be addressed to the Secretary, Louisana State Live Stock Sanitary Board, State Capitol, Baton Rouge.

PART II. THE BEST CROPS TO GROW FOR HOGS.

By W. R. Dodson.

In those States where corn is the chief crop of the farm, hogs are raised largely on this grain. While excellent corn can be grown in every portion of Louisiana, hogs can be grown most profitably under a system that permits the hogs to harvest a large portion of their feed in the form of green forage. While grain fed hogs grow more rapidly than those that are supplied with abundance of forage and a small quantity of grain, the latter system of feeding gives a more profitable hog in Louisiana. It is the purpose of the following discussion to give what the writer thinks has been demonstrated to be the best and most economical methods of growing and feeding hog crops.

Hogs should be bred so as to give one litter of pigs in the early fall, and the second in late spring. Good management will accomplish this distribution of breeding. The fall litter should be carried through the winter and spring largely on green crops that may be grazed, and brought to maturity during the late summer and fall at a year old or slightly more, on matured crops which the hog is allowed to gather. The spring litter should be maintained largely on green crops until about the first of August, and marketed at six to eight months old, with more grain and concentrated feed than received by the first litter. Exclusive feeding for a period of two weeks on concentrated dry feed just prior to killing, will give meat equal to that fed exclusively on grain throughout the fattening period.

Of the crops that can be grown to furnish good grazing during the winter months, rust proof oats, southern grown rye, barley, dwarf Essex rape, the clovers and alfalfa are all available in some localities, and most of them are available in all localities in Louisiana. For mature forage for the fattening period, cow peas, soy beans, velvet beans and peanuts are easily the leaders. Of the root crops that may be grown, sweet potatoes, artichokes and cassava are available, and stock beets, rutabagas and turnips may be used from early winter to midsummer as supllemental feed. Of the concentrated feeds available for the finishing period, and for supplemental forage when it may be desirable, we may use our corn, oats, rice polish and rice bran, and a very small quantity of cotton seed meal. No doubt peanut meal may become available in the near future, if the crop of peanuts increases as the interest in this crop at present indicates it will.

OATS FOR WINTER GRAZING FOR HOGS.

The genuine rust proof oats, from Louisiana grown seed, may be sown as early as the second week in September, if moisture of soil is sufficient to germinate the seed, or they may be sown as late as the latter part of November. From early sowing good pasturage will be furnished in four weeks from date of sowing. We prefer to sow not less than a bushel and a half and not more than two bushels per acre. The land should be well prepared and the seed covered to a depth of one and a half to two inches. Late sowing should not be covered so deep. If a grain drill is not available, a good disc harrow serves the purpose well to cover the seed. An ordinary iron tooth harrow will serve as a last resort. Sowing seed in advance of the turn plow is sometimes practiced, but the results are uncertain, and this is not considered good practice.

As to whether or not land should be pastured during wet weather, depends upon the quality of the land. If the soil is deficient in vegetable matter, and has a large amount of clay, it is liable to become very hard in dry weather, if pastured during wet weather. Little if any Louisiana land will be injured by pasturage when the soil is dry enough to permit of plowing. If land is to be selected especially for winter pasture crops that do not form a permanent sod, the sandy soil should be selected.

If fall sown oats are not pastured later than the first of February, or even the middle of February, a good crop of grain will be produced in May, after which other crops may be planted.

We are frequently asked for information as to how many hogs an acre of oats will maintain during the winter. This question can be answered only with very wide limitations. It depends upon when the oats are sown, how rich the land is, how cold the winter is and how much wet weather we have. Oats sown in early October on good land, in an average year, should maintain four or five sows with their fall litters of pigs, if the mothers are fed a moderate amount of concentrated feed at first, diminishing the amount as the pigs eat more oats. One-third to one-half a normal feed of grain to the mothers will give a good flow of milk when the oat grazing is good. When the pigs begin to eat, a very small quantity of rice polish or bran will add much to their thrift.

It is the opinion of the writer that it is better to take the hogs from the oats and allow a crop of seed to mature, than to allow the hogs to continue to graze the crop until summer. This matter will be referred to again under the discussion of clovers.

The question is frequently asked, is not the oat crop an exhaustive one on the soil? It makes only a moderate draft on soil fertility. If the oat crop is followed by cow peas or peanuts, the land will not be depleted by the production of the two crops more than would be represented by the removal of the phosphate and potash. No just objection can be made to oats on this point, as the cow pea and the peanut greatly enrich the soil in nitrogen content.

As a grain crop, oats should produce twenty to thirty bushels per acre in the hill lands, from thirty to sixty bushels in the bluff soils, and greater yields in the alluvial lands, especially in the northern portion of the State.

In the purchase of seed oats, Louisiana grown seed should be secured by all means. Texas grown seed are very apt to contain Johnson grass seed, and frequently oats sold as Texas Rust Proof Turf oats, are only partly resistant to rust.

Spring-sown oats do not ordinarily give satisfactory results for any purpose.

If fertilizer is to be used, a moderate quantity of nitrogen and phosphoric acid is desirable. One hundred and fifty pounds of high grade acid phosphate and the same amount of cotton seed meal per acre, on the poor quality of land should start the crop off well. In the sandy lands of the hill parishes, a light top dressing of nitrate of soda, in the spring, will give good results in many cases.

After extended experimentation and observation, the writer is convinced that there is no better winter grazing crop for hogs, that is available to all the State, than rust proof oats, sown in the early fall.

CLOVERS.

Clovers should be sown in the early fall, if the season is favorable. They are more likely to be killed by drought than are the crops that grow more vigorously. Early October is the best time, if the season is favorable. The Medium Red is the best variety for the bluff lands and the alluvial soils, and the better quality of clay soils of the hills. The Crimson Clover is the best for the sandy soils of the hills, and the Alsike will grow in some stiff, poorly-drained lands not suited to the other clovers. It is advisable to sow about twelve pounds per acre. At the present time the seed are unusually high in price, costing from seventeen to twenty cents per pound. Clovers may be sown alone or with oats. If sown with oats use about eight pounds per acre. When desired for hog pasture to be used after the animals are taken from oat pasture, we prefer clovers sown alone. The land should be well prepared, the seed sown broadcast and harrowed in, so as to not cover the seeds more than an inch deep. If sown with oats it is best to sow the oats with a drill first and then sow the clover and harrow lightly. If oats are not sown with a drill, clover and oats may be sown and harrowed in together, but we prefer separate sowing and harrowing. Clovers will furnish good grazing land by the time the hogs are taken from the oats. They will supply the very best quality of grazing until the native grasses and white clover in pastures of sod are good, and then make a good crop of hay in late May. If clover is sown in early fall and not pastured it will be ready for harvest in early May, when the season is likely to not be very favorable for hay making. Pasturing retards the development and brings the hay cutting time at a more favorable season. For this reason clover for pasture for hogs fits well with oats, as well as furnishing an abundance of most excellent feed. If permanent sod of Bermuda grass and white clover is available, and it should be provided, the hogs can be gradually cut off the cultivated clover pasture in time to allow a good hay crop to mature. If the clover is not grazed too severely, and the hogs are removed in the early part of April, a maximum of about two tons of clover hay may be harvested about the last of May or the early part of June, and a small second cutting secured in about five to six weeks later. The clover will not survive through the summer, and it is then best to plow the land and plant a summer crop. Clover hay is a very fine hay for dairy or beef cattle, can be fed to advantage to hogs, but when fed to horses produces an excessive flow of saliva, which becomes disagreeable to parties handling the animals. No other ill effects follow. Clover hay is more difficult to cure than our Lespedeza, or Bermuda grass.

All clovers greatly enrich the soil, and should be much more extensively cultivated for grazing purposes, especially for hogs.

When oats and clover are sown together and harvested at the time the oats are in the "dough" the quality of hay is very superior, and is much more easily cured than is clover alone. If this hay can be chopped in a machine before it is fed, there is little waste and the combination is most excellent for all farm animals.

DWARF ESSEX RAPE.

Dwarf Essex Rape furnishes good winter grazing for hogs, on rich land. It is useless to plant it on poor soils. The seed should be sown broadcast, at the rate of five to ten pounds per acre, and harrowed in. Early October is the best time to plant, if the season is favorable. This crop makes a luxuriant growth throughout the winter, but does not give the returns in feed value that its appearance leads one to expect. Oats have given us more money returns, and oats are preferred by hogs as a grazing crop There is no return from a rape crop after the grazing, as there is with oats. In short, Dwarf Essex Rape will give a good crop on rich lands, if sown early, but oats will meet every requirement that rape will, and will generally give better returns.

RYE.

Rye affords good winter grazing, and may be sown from late September to early December. Southern grown seed must be used. If Northern seed are sown the leaves will make a flat growth on the ground during the early winter and afford little grazing. The Southern grown seed will stand erect and give good grazing throughout the winter. During an average winter, rye will not give as much grazing, on most soils, as will oats. If the winter is quite cold, rye will frequently give a better growth than oats. About one and a half bushels per acre should be sown, either broadcast or in drills. Some prefer broadcast sowing with all grains designed for winter pasture. No definite experiments have been made along this line in Louisiana. Oats, rye and barley sown with a drill seem to withstand cold weather better than that sown broadcast, but broadcast sowing seems to give a more complete covering of soil in early winter.

Rye matures about a week to ten days in advance of oats, other conditions being the same. On the Experiment Station grounds we prefer oats to rye for winter pasture, but there may be some conditions under which rye would be preferred.

If one cannot secure home grown seed, Georgia seed are to be preferred. It is very important that Southern grown seed should be secured.

BARLEY.

Barley thrives in Louisiana, when the season is not especially favorable for the development of the grain rust. When the fall and winter season is dry and cool, barley may do exceedingly well, and from a single year's experience, lead one to think it the best winter grazing grass to be had. The following year it may be almost a complete failure. It is more variable in its habits, with us, than any of the grains that may be sown in the fall of the year.

Those wishing to try it should sow from one and a half to two bushels per acre, as they would oats, in early October, or even in late September. As with oats, planting may be made as late as early December, but the later the planting is made, the longer will be the period required to produce sufficient growth for good grazing.

If grazing is discontinued in early February a fairly good crop of grain may be secured, if the plants are not badly damaged by rust. Probably twenty bushels of grain would be a maximum crop, and ten bushels an average crop on the thinner soils, and better returns from the better soils.

WHEATS.

There is no justification in planting wheat for the grazing of hogs in Louisiana, as none of the varieties makes better grazing than oats, and all are more or less subject to the grain rust, and some years the wheat will be almost entirely destroyed in the late winter by a heavy attack of rust. It is possible that we may obtain a wheat that will make good winter grazing in the northern portion of the State, and then make a fair yield of grain, but for the present it is the part of wisdom to plant sparingly of wheat. For those who wish to try wheat, give preference to varieties grown in Georgia and Southern Tennessee. The Mediterranean is one of the best.

VETCHES.

The hairy vetch and the Oregon, or smooth, vetch have been extensively advertised. We have grown vetches for ten or twelve years, and have not yet felt justified in urging their adoption throughout the State. In the judgment of the writer, the hairy vetch is to be preferred to the smooth. It is better to plant them in oats than to plant alone. When good seed are secured, and favorable conditions prevail, both varieties make a good growth, and afford good grazing. For those who wish to try vetch, plant about thirty pounds per acre with oats, or sixty pounds per acre, if planted alone. In a few instances known to the writer, vetches have been successfully planted in Bermuda sod, without any plowing being done, or any attempt made to cover the seed. Tests at the Experiment Stations have not been successful after this fashion. The seed should be covered in regular planting to about the same depth as oats and so can be planted at the same time as oats. It has been our experience that if the vetches are grazed too close to the ground the plants will die.

The following is a summary of the good points of the vetches: They grow during the winter, are not killed by cold in the southern portion of the State and are not apt to be severely injured anywhere in Louisiana. They gather nitrogen from the air. They make a very rich hay, and fairly good pasture if the pasture is not overstocked. Where the seeds ripen they will remain over summer without germinating, but will grow the following fall, even if covered to moderate depth by plowing.

The objectionable points are: High cost of seed, unreliability of seed, and the fact that both seed and hay cannot be made from the same crop. Louisiana does not furnish favorable conditions for seed crop for market or enlarged planting, but the crop may reseed the land on which it grew if pasturing is discontinued early enough.

We have in Louisiana two or more wild vetches that are of some value for grazing for hogs. Their growth should be encouraged, in pasture lands and wood lots.

ALFALFA.

Where alfalfa can be successfully grown, it is a desirable crop for grazing hogs, and makes excellent hog feed in the form of hay. In fact, hogs eat alfalfa hay probably better than any other that we can grow, and they thrive on it when a little grain feed is added. Alfalfa should not be grazed very much during the periods when grasses and weeds thrive—that is, during the late spring and during the summer rains. The grazing animals eat the alfalfa only and the grass and weeds are given an opportunity to develop to an extent that enables them to soon overshadow the alfalfa, and eventually to kill it out. During good weather in winter the crop is not seriously injured by pasturing hogs on it, and the animals thrive with little or no other food.

Alfalfa can be grown on most of the alluvial lands along the Red River, the well-drained stiff lands of the Mississippi, and on many of the bayous throughout the State. Permanent water should not rise within three feet of the surface of the soil for any considerable period of time, else the alfalfa will be killed. In the southern portion of the State, fall planting is most desirable. In the northern portion of the State, fall planting is most desirable if favorable season can be secured, but dry weather is apt to interfere. Spring planting is therefore frequently resorted to with satisfactory results. It is best to use about thirty pounds of seed per acre, covering not more than an inch deep. Special effort should be made to have good drainage. On soil that is not naturally suited to alfalfa, a light dressing of stable manure, that has been sprinkled with soil from a successful alfalfa field, is recommended, though this will not always insure success. Grazing the early spring crop of alfalfa with hogs sometimes is resorted to for the purpose of delaying the first cutting, as early fall sowing is apt to give a crop ready for harvest before good hay making weather prevails. An acre of alfalfa will sustain from fifteen to thirty hogs weighing from one hundred and twenty-five to a hundred and seventy-five pounds, but it is probably best to not carry so many, if the alfalfa is to be retained for a long period.

The best use to make of alfalfa in connection with hogs is to pasture it during good weather in the winter time, and make hay of it during the late spring and summer, and feed the hay to the hogs at such periods as may be necessary to supplement other feed, or to become the main feed of sustenance.

BERMUDA GRASS AND WHITE CLOVER.

No better early spring and summer pasture can be secured at nominal cost than in Bermuda grass and white clover. Hogs do well on it. Bermuda grass sod is easily secured anywhere in the State. In many places it is sufficiently well established to make a sod in one year if allowed to do so. Where it is not established, the field may be planted in corn and after the last cultivation small tufts of sod planted at intervals of a few feet in the corn rows, and Bermuda will be established pretty well by the end of the season, and the second year will make a complete sod early in the summer. White clover seed can be sown at the rate of four or five pounds per acre in this sod in the early fall, and sometimes a set may be secured the first year. If not, the clover will reseed the land, if not pastured excessively during early spring, and thereafter the white clover will make very early spring pasture that will give good service in the way of hog feed, and will last until late spring, when the Bermuda becomes good. This combination comes nearest to being perpetual pasture of anything that we have been able to find, and we have tried all combinations that seemed to give any promise of meeting this desire. We have found that crops which thrive during the winter and make a heavy growth, crowd out the Bermuda and leave the land bare in large spots in early summer. Spotted Medic, and other burr clovers, have not been as satisfactory for combination purposes, though they make a more vigorous growth in early winter. Animals have to be trained to eat the burr clovers.

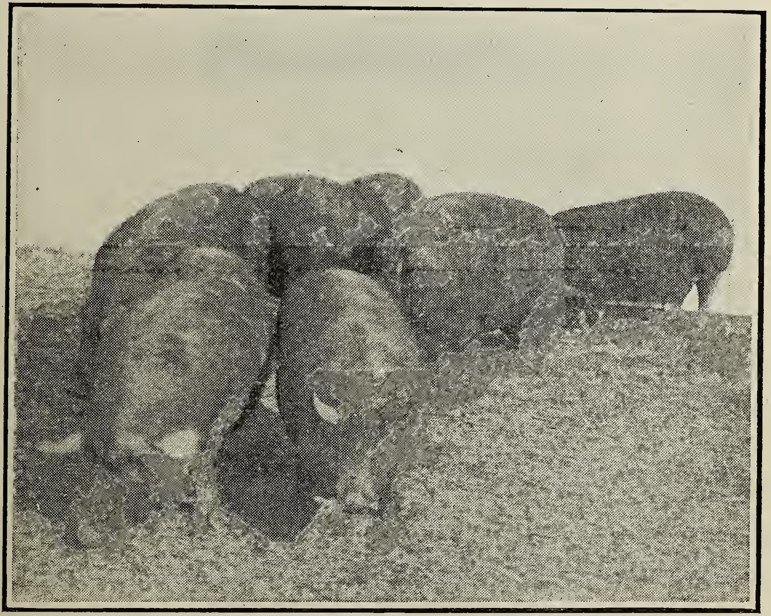
SUMMER CROPS FOR HOGS.

SORGHUM.

The sweet sorghums make a very acceptable forage for hogs in the early summer, coming at a time when it is sometimes difficult to have other green feed. Sorghums are most serviceable for grazing during May, June and early July. The results of experiments at the station have not indicated the high value of sorghums as a grazing or soiling crop for hogs that they are reputed to have. In fact, we do not place a very high value on them, and commend their use only as a makeshift. The only strong points in their favor are that they give quick returns, and may be had about the time winter crops are exhausted and summer crops are not sufficiently matured for best service. The Early Amber, Early Orange or Coleman are to be preferred. Any of these may be sown in drills as soon as danger of frost is passed, though growth will not be rapid until warm weather prevails. The middle of March to the first of April is ordinarily a good time to plant sorghum. However, the crop may be planted as late as the first of August. When sown in drills, with rows three and a half feet apart, it takes about twelve pounds per acre to give a thick stand. It is best to plant the seed thick so the stalks will be small. The crop should be well cultivated until it is about two feet high, if it is to be grazed, or as conditions may require, if it is to be soiled. Planted in early spring, the sorghums will mature in about a hundred and ten to a hundred and twenty days. Planted in late June or early July, they will mature in sixty-five to seventy-five days. Soiling may be begun as soon as the stalks begin to head, but are more valuable as the seeds mature. Soiling involves considerable labor, but is sometimes to be preferred. In many instances the batture along the Mississippi River offers considerable areas of rich soil that is useless except for a crop of quick maturity. Sorghum may frequently be planted to advantage on such land, and grazed or soiled to hogs. Sometimes sorghums may be worked in as catch crops, between other crops, because of their early maturity.

SWEET POTATOES.

Sweet Potatoes grow well in all portions of the State, and in all soils except occasional areas that are excessively rich in nitrogeneous matter. Sandy soils in the alluvial lands are generally better suited to potatoes than stiff lands. In the hill lands, the loams and mixed sandy soils are the best. In some localities, distinctly clay soils produce the best potatoes. This crop re-



EXPERIMENT STATION HOGS ON SWEET POTATOES.

quires only a moderate amount of moisture. Plants may be put out from early spring until the early part of August. When planted early in the spring, they do not produce large roots much in advance of plantings made later. For this reason they are especially adapted for planting after spring crops have been harvested. Oats and clovers harvested in May and June may be followed by sweet potatoes to advantage. If early plantings are made in small areas, they will afford vines for planting in June for extensive areas. The large yams or some of the large white varieties are to be preferred. The Southern Queen produces large yields. The yams seem to be preferred by hogs, though this has not been thoroughly established. A bushel of seed potatoes put in a hotbed early in the spring will give slips enough to plant sufficient area to afford vines for two acres of planting soon after oat harvest, or two or three times this area for late planting. Sections of vines containing three leaves make a good size for setting. Vines may be rapidly set when the soil is quite wet by pushing one end of the vine into the soil with a stick and packing the dirt around it, or in dry weather holes may be necessary to receive a little water just in advance of the setting. Sometimes a shallow furrow is opened with a plow and the vines dropped so they lie across the furrow with one end at the bottom and another furrow is thrown on the vines and a roller is run over them to compact the soil.

Planted in June and early July, they will be ready for feeding about the middle of October. Hogs turned on them then will root more potatoes than they will eat, but there will not be very much loss from this cause. An acre of potatoes should feed eight to ten hogs, one-year-old, for sixty days, if one uses some supplemental feed in the form of rice polish or rice bran. We have uniformly secured good results from feeding hogs in this way.

The writer considers sweet potatoes as pre-eminently the best root crop for hogs for fall and early winter grazing. The cut-over pine hill lands will likely have their agricultural development as a hog-raising country from the fact that these soils are pre-eminently suited to the production of sweet potatoes, peanuts and cowpeas, and they produce fair winter oats for winter grazing. That this combination of crops will produce the most profitable hogs that can be raised in the United States, is the firm conviction of the writer.

PEANUTS.

Peanuts will grow in any soil in Louisiana, but are most productive in the moderately sandy soils. The largest yields are secured from the grey sandy hill lands, and the red clays of the hills of North Louisiana, that are only moderately stiff. Peanuts are most excellent hog feed. Planted in early spring, they are

SPANISH PEANUTS.

ready for grazing about the first of August. Planted after oats and clovers in June, they are ready for grazing about the latter part of September. They come in very timely for feed between cowpeas and sweet potatoes. It pays to plant plenty of seed and secure a thick stand. About one bushel of shelled peanuts per acre is required of the Spanish or Virginia. The Spanish being smaller, will give a thicker stand for the same planting, but they will permit thicker planting than will the large types. Plant in rows as narrow as possible to permit comfortable use of implements in cultivation. Thirty to thirty-six inches is a good width. Hills four inches apart are not took thick, though eight to twelve inches is commonly recommended. More than twelve inches is too thin.

The Spanish has a decided advantage of the spreading varities in its erect habit of growth, permitting of easier cultivation, and when it is desired to harvest the tops for hay, they may be cut more readily with a machine before the peanuts are harvested or grazed.

It is desirable to feed hogs a small amount of corn when they are on peanuts to more nearly balance the ration.

An acre of peanuts should feed eight to ten hogs for thirty days or more, when the hogs weigh in the neighborhood of two hundred pounds.

If more peanuts are planted than the hogs can consume in the time desired to feed them, they may be harvested and afterward fed as dry feed to hogs or any other kind of livestock with good results.

The present price of peanuts is such as to render their culture for market very profitable in soils best suited to growing a good nut that can be harvested clear of adhering soil, and where this crop is raised as a money crop, only enough hogs should be maintained to consume the inferior pods and clean the fields of what would otherwise be wasted. It is very probable that the peanut crop will increase until the market is somewhat depressed and then the crop will be profitable when converted into pork. Early planting may be made for early grazing. Hogs fed on peanuts produce meat that cures with a darker color than that obtained from corn-fed animals, but hams from hogs fed on peanuts and finished on corn for ten days or so before slaughter, are not to be excelled anywhere.

Peanuts greatly enrich the soil in nitrogen, and when the crop is pastured the land receives from the crop a very appreciable amount of vegetable matter. No more desirable crop can be grown in many portions of Louisiana, where conditions are peculiarly favorable to the growth of this most excellent feed crop.

CASSAVA.

Cassava is well suited to the sandy lands of the State. Short sections of the stems are cut before the period of danger of frost, and placed in moist sawdust, as the horticulturist treats cuttings from grape vines, and these sections are planted in the early spring. The crop occupies the land all summer and requires cultivation until late summer. Plant in rows four feet apart, and have the hills about two feet apart in the row. The root only is valuable for feed. These roots cannot be harvested more than a week or ten days in advance of feeding, as they will rot in a short time after being removed from the soil. Very satisfactory gains have been reported in Florida from feeding cassava to hogs and to cattle. In Louisiana we have found that we can make a larger tonnage of sweet potatoes than we can of cassava, and make the crop at about one-third the cost. We do not consider that cassava should find a place on the average farm in Louisiana, but we receive so many inquiries about the plant that this data is given here. There are also those who wish to try it for their own satisfaction, and these brief suggestions for cultivation are given. The cuttings may be secured from most of the nurseries of Florida, names of which can be secured from the Experiment Station.

SOY BEANS.

The rapidly increasing popularity of soy or soja beans in Virginia, Tennessee and some other sections of the country has caused a great deal of inquiry about soy beans for Louisiana. We have grown a large number of varieties for a number of years, and have not yet secured results that lead us to be very enthusiastic about them. It seems very probable, however, that some of the hill lands may be devoted to soy bean culture with moderate profit, either for grazing hogs, or for the seed market, allowing hogs to follow the harvest and gather the shattered beans. It will be well for the farmers throughout the State to try the Mammoth Yellow, the Ito San, and possibly one or two other varieties. They may be planted from early spring to late summer. Probably the best use to make of them is to plant them after oats or other spring crop, planting in rows no wider than will permit of cultivation, and cultivate two or three times. They thrive well on rather poor soils. On rich soils, the yield of fruit is less but the growth of vine more rank. It will require about one-third to one-half bushel per acre for planting.

When seed are desired, the crop should be cut as the beans begin to ripen, and before the pods begin to split open. They may be thrown in small cocks, after wilting, and allowed to remain two or three days, and then stacked in an open shed or according to special methods. Hogs may then be turned into the field to gather the shattered beans. Soy beans ground and mixed with corn make a most excellent feed for hogs, as reported by some feeders. If they are to be used as forage for hogs, they should be pastured as soon as the pods are fully matured, and before the seeds shatter on the ground.

For hay, soy beans will be more desirable under some conditions than cowpeas, but for forage for hogs the writer prefers the cowpeas.

COWPEAS.

Cowpeas are well known throughout Louisiana. They are most commonly planted in corn at the last plowing for fertilizing the soil, and for hay. They should be almost universally planted in corn. If planted alone, early spring planting (late March and early April) may be made broadcast or in drills; if in drills, they should be cultivated once or twice. Broadcasting alone or in corn, at last cultivation, requires from one to two bushels of seed per acre. In drills, three pecks to one bushel is ample.

Cowpeas make very good pasturage for hogs. They are ready for pasturage at a time when we need them. When planted early, they may be brought in before peanuts, or the cowpeas in corn may be pastured for a month before peanuts, following oats, are ready.

Hogs may be allowed to gather both the corn and the pea crop profitably, if portable fences are used, so that the animals

COWPEAS ON EXPERIMENT STATION.

can be confined to an area that they can harvest in about ten days.

When first turned into corn and peas, hogs will break down more corn than they will consume, but later the shattered corn will be eaten by them, so that the losses are small. Corn may be harvested in this way before it is sufficiently dry to be gathered for the barn. Hogs may be put on the average crop about the last week in July, and kept there until the first of October. In that portion of the State where a heavy crop of seed is produced, there may be danger of hogs consuming too large a quantity of the seeds.

The New Era pea is becoming popular where the Clay and Speckled peas do not fruit well. This variety generally makes a pretty good crop of seed and a fairly vigorous vine, and it matures early.

Cowpeas are an exceedingly desirable crop as a soil renovator, a hay crop, and as a grazing crop for hogs.

GROUND ARTICHOKES, OR JERUSALEM ARTICHOKES.

The ground artichoke thrives in rich soils in all portions of Louisiana. A sandy loam soil with plenty of humus gives the best crop. If grown for hog feed, they should be planted in rows about four feet apart, and the hills about a foot to a foot and a half apart in the row. They must be planted as soon in the spring as danger of frost is past. It requires from three to eight bushels to plant an acre, according to the size of the tubers planted. Plant as Irish potatoes are planted. It is not always easy to get a stand, but they are vigorous growers when once started.

The seed are expensive, the crop requires considerable cultivation, and hogs are not as fond of them as some seed catalogues and advocates of their planting would have us believe. Sweet potatoes meet every requirement that the artichoke would meet, make as large returns, occupy the land a shorter time, and are less difficult to handle in every way, as well as being a less expensive crop in the matter of seed and the disposition of the tops. We, therefore, see no reason for advocating the cultivation of artichokes for hogs, but have given the above data because we have frequent letters inquiring about the crop.

SUPPLEMENTAL ROOT CROPS

Winter-growing root crops may be used to advantage as a supplemental feed throughout the greater portion of the State. Rutabagas and stock beets are the best crops for this purpose, although stock carrots may also be profitable, especially in the northern portion of the State, as they are not as susceptible to freeze as are other root crops.

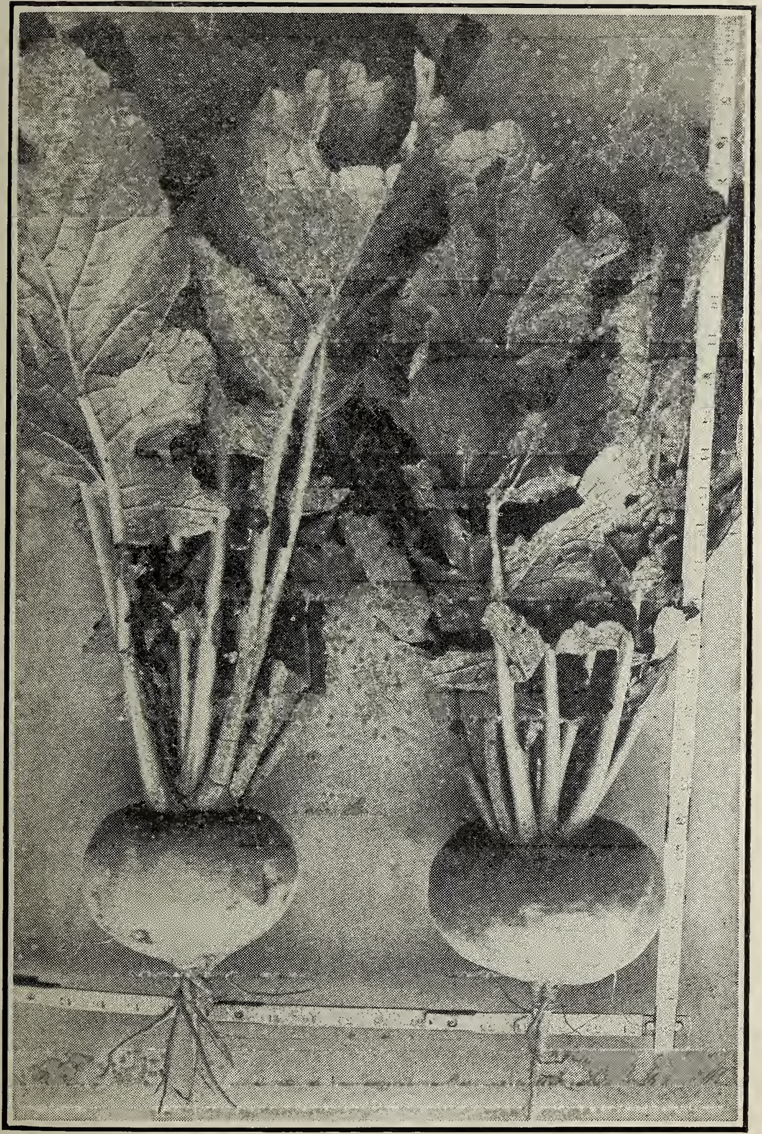
STOCK BEETS.

On rich land stock beets will make as large tonnage of succulent feed as will any crop that can be planted for winter growth. In the southern portion of the State, on good land, twenty-five to forty tons of beets may be secured, if they are planted in early October and allowed to grow until the following April or early May. It is best, however, to plant them in early fall and begin feeding as soon as they are large enough, which will ordinarily be about one hundred to one hundred and fifteen days after planting. If the planting is made the latter part of September, or early October, we can begin feeding them about the middle of January and continue until midsummer, if desired, gathering from the field enough at one time to feed for several days. The roots will keep a week or ten days after they are harvested. Hogs may be maintained on beets alone, but it is advisable to use them only as a supplemental feed, and in this way they can be used to advantage. When bad weather is anticipated, one can harvest a quantity of beets and feed them to the hogs during times that pasturing the fields would be injurious to the land, as well as exposing the hogs to inclement weather.

Plant about eight pounds per acre. The seed at present are high, costing about twenty-five cents a pound. Plant in ridges, convenient distance apart for cultivation, and drill in the row as garden beets and later thin to a stand of one plant to every ten or twelve inches, or plant a number of seeds together in hills a foot apart in the row and afterwards thin to one plant in a hill. The seed do not have a high percentage of vitality, hence it is necessary to plant thicker than one desires the plants.

Late plantings may be killed by freezing temperature. A sharp freeze will kill the outer leaves of large beets, but the new

STOCK BEETS ON EXPERIMENT STATION.



TURNIPS.

leaves quickly come out and the plant recovers rapidly from the damage. Cultivate with any convenient implement to keep the soil mellow and free from weeds and grass. Begin feeding as soon as the roots are large enough, gathering as demands may require. A hog weighing a hundred and fifty pounds will eat from ten to fifteen pounds of beets per day.

In the southern portion of the State beets and rutabagas may be sown on early fall plant cane, and be harvested before time to offbar the cane in the early spring.

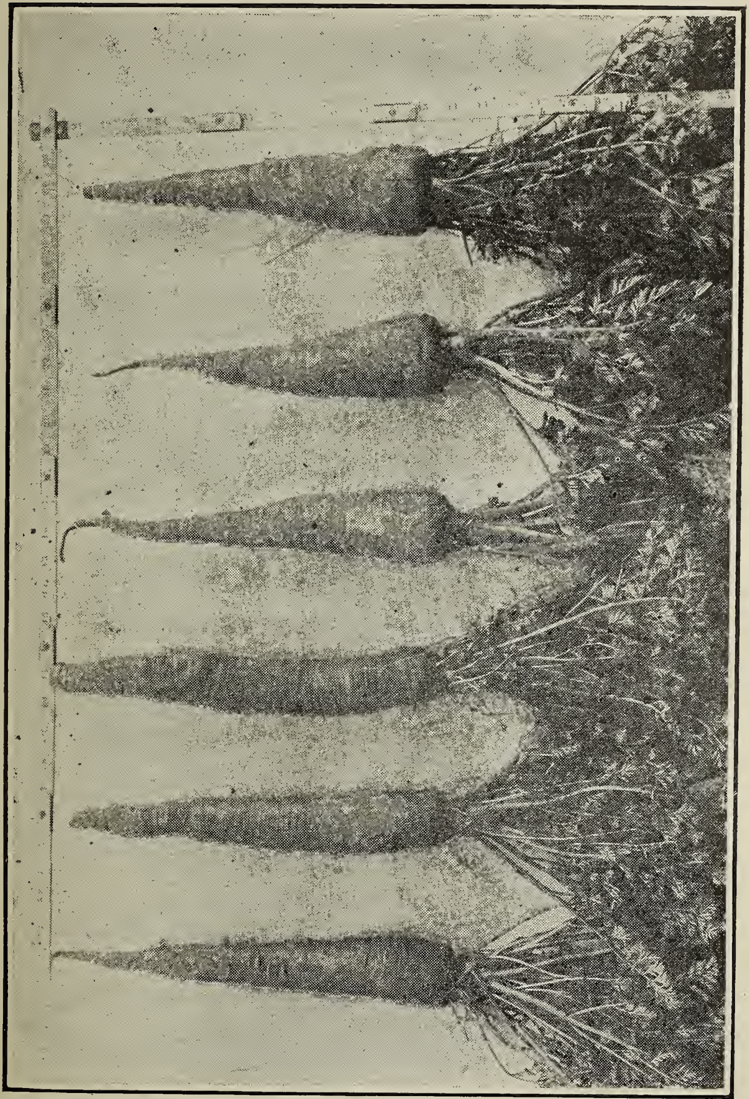
Giant Long Red is the largest yielding variety with us, although the other varieties do well.

RUTABAGAS.

Rutabagas may be fed to advantage, also, as a root crop for hogs. They develop more rapidly than do beets, but do not give such large yields. They may be planted earlier, and therefore may be used conveniently to precede beets as a source of succulent feed. In the northern portion of the State we can plant the seed in July and August, and have roots large enough to feed in about eighty days. We consider it best to sow them in rows and cultivate them well. They should only be planted in moist rich land. Land that will make forty bushels of corn should make fifteen tons of rutabagas. In the extreme northern portion of the State the crop may have to be housed for use during January and February. Three to four pounds of seed per acre should be planted, and the plants thinned to a stand.

STOCK CARROTS.

Stock carrots will withstand a lower temperature than will stock beets or rutabagas. For that reason they may be more desirable under some conditions. We have found that White Belgian and the large Yellow Victoria stock carrots will produce from twelve to fifteen tons of roots, in rich, mellow soil, in four months' time. Late September or early October is the best time to plant them, although they may be planted most any time up to January, although the late planting will give much smaller yields. Plant in ridges and leave the plants quite thick in the drill. Cultivate as may be required. Hogs are quite fond of carrots, after they have become accustomed to eating them, and good results have been secured in feeding them. They may be fed from February to the latter part of April.



STOCK CARROTS.

ROTATION OF CROPS FOR HOGS

After many experiments we have come to the conclusion that the following succession of crops will give the cheapest pork in the greater portion of Louisiana: Oats and clover to be sown in separate fields in October, the oats grazed until early February, when the hogs should be transferred to the clovers, allowing the oats to make a crop of grain in May. Pasture the clovers until the middle of April or first of May, and transfer the hogs to Bermuda pasture, and allow the clover to make a crop of hay. Two fields sown to mixed oats and clover may sometimes be preferable to the single crops, using one field for early pasture and grain, the other for late pasture and hay. Keep hogs in Bermuda grass until cowpeas are ready to be grazed, in July for early peas or August for later plantings; pasture cowpeas until peanuts are ready, this crop having been planted after the oats are harvested. Continue on peanuts until sweet potatoes are ready for grazing, and continue on sweet potatoes until the hogs are ready for the market. When the hogs are on cowpeas, feed them a moderate amount of corn. When they are on peanuts feed half as much corn as when on cowpeas. When on sweet potatoes feed as much rice polish or rice bran as they were fed corn on cowpeas. The feeding period actually begins with the cowpea pasture, as the main purpose up to this time is to keep the animals growing nicely at as low cost as possible.

There will be times when a little grain ration may be necessary. One must exercise judgment in matters of this kind.

PLAN OF THREE-YEAR ROTATION.

The following succession of crops has been found by experiment to furnish a desirable continuity of feed and form a good series for easy rotation: Oats and clover, sweet potatoes, corn and peas, oats and clover, peanuts; then going back to oats and again following the same series. This gives the land a complete series of these crops in three years, and affords on three fields every crop each year. To carry out the plan one should divide the area to be devoted to these crops in approximately three equal fields. In field one, sow oats and clover in October or early November; in field two, plant corn in early spring and sow cowpeas in the corn at the last cultivation; in field three, sow oats and clover in early fall and the succeeding summer plant peanuts. Each field will then have the same series of crops, but beginning at a different point in the cycle.

To recapitulate, the following may make this plan more explicit:

Crop 1—Oats and clover.
Crop 2—Sweet potatoes.
Crop 3—Corn and peas.
Crop 4—Oats and clover.
Crop 5—Peanuts.

The series in field one would be crops 1, 2, 3, 4, 5, 1, 2, etc.
The series in field two would be crops 3, 4, 5, 1, 2, 3, etc.
The series in field three would be crops 4, 5, 1, 2, 3, 4, etc.

PLAN OF FOUR-YEAR ROTATION.

A four-year rotation can readily be arranged as follows:

First year—Corn and peas, followed by fall sown oats, or mixed oats and clovers.

Second Year—Oats and clovers, fall planting of root crops.

Third year—Roots harvested, peanuts, fall sowing oats and clovers.

Fourth year—Oats and clovers, followed by sweet potatoes.

Fifth year—Return the same crops as the first year.

The same plan of rotation should be followed in four different fields, thus giving each set of crops every year—that is, Field No. 1 should start out with corn and peas, Field No. 2 with oats and clovers, Field No. 3 with root crops, followed by peanuts, and Field No. 4 should start with oats and clovers, to be followed by sweet potatoes. The succession is then easily followed, and if the same succession is followed in every field the crops will be given in regular succession, and no confusion can possibly follow. This is not at all a difficult matter if one will give it a few minutes' consideration and have the plan well understood.

The above plan is the one now being carried out for hog experiments at the Experiment Station at Baton Rouge, and the one that we consider the best under average conditions, when hog feed alone is considered.

If this plan is not perfectly plain, write the crops in order given on the rim of a circle, and it will then be easy to read around the circle, starting from any desired crop.

METHOD OF ESTIMATING AMOUNT OF GRAZING THAT CAN BE SECURED FROM A CROP.

We are so frequently asked to state how many animals can be pastured on a given crop that the following is given as the basis for making a guess, for, at best, only a guess can be made, as there are so many variable factors entering into the consideration.

Suppose a man has a cowpeafield that he wishes to graze, and wants to know how many hogs to put on it to graze it down in a given time, or if he has a given number of hogs he wishes to provide grazing for and wants to plant accordingly: Three to four weeks will ordinarily be the most favorable period for grazing cowpeas. Most men make a fair guess at how much hay a given area would make if harvested for that purpose: Let us suppose cowpeas would make two tons of hay per acre; there would, then, be the equivalent of about one ton of leaves, stems and pods that the hogs would consume, as a minimum, and a ton and a half as a probable maximum, under most favorable conditions. We then consult the standards of feeding and see how much a hog of a given weight will require. For instance: We find that a hog weighing 170 pounds, such as we would have at nine months old, under the pasture system of raising hogs, will require, per day, 4.6 pounds of digestible dry matter, of which .58 pound shall be protein and 3.4 carbohydrate. Then, looking at our table of compositions, we find that a hog would have to consume the equivalent of ten pounds of dried cowpea vines per day to supply the necessary amount of carbohydrate, although there would be a large waste of protein. On the other hand, two pounds of corn and the equivalent of five pounds of cowpea vines dry would almost exactly furnish what the hog would require for fattening, and he would consume this quantity.

CORN AND COWPEAS.

Since the good grazing period would not exceed thirty days, we must have one-thirtieth of the crop consumed each day. If we suppose, as above suggested, that the hogs will consume one-half the total dry matter, which would be one ton, we must have enough hogs to consume about seventy pounds of dry matter per day, which would require seven hogs, if no corn is fed, or fourteen hogs, if we feed corn as suggested. Of course, if only one-half this yield is estimated, we would correspondingly reduce the number of hogs. This is about what we find from practical experience can be counted on. Of course, there are many variable factors that may influence the amount of grazing: the weather may be such as to cause the peas to shed their leaves rapidly, or second growth may begin, damp weather may cause vines on the ground to mould and be rejected by the hogs, etc.

An acre of cowpeas grazed by hogs—say, ten in number—should give from three hundred to three hundred and seventy-five pounds of gain in pork in twenty to twenty-five days' time, if two pounds of corn is fed each day to each hog.

If estimates are carried out in detail, as above suggested, it will be seen that the corn of one acre, and the oats from an acre, will feed hogs for a balanced ration for grazing two acres of cowpeas, one acre of peanuts and an acre of sweet potatoes, given in the suggested form of rotation, and very little, if any, feed need be purchased. Circumstances may make it profitable, however, to sell the oats and purchase rice polish. From experiments carried on at the Experiment Stations, it would seem that one may count on producing about seven hundred and fifty pounds of pork per acre per year, under this system of cropping. Some farmers will do much better than this; some will not do so well. This estimate is based on results secured on good land.

PORTABLE FENCES.

By S. E. McClendon.

It is convenient if one can arrange fields so as to afford proper rotation without building special fences. Even then, however, it is frequently desirable to pasture small areas, limiting the range by temporary fences.

To pasture small areas with hogs it frequently becomes necessary to have portable fences. One that can be easily moved

LINE OF PORTABLE FENCE.

and quickly set up, is made by taking three pieces 2 by 4 inches, 4⅔ feet long, and nailing five boards, 1 by 4 inches, 14 feet long—a convenient length—to them as shown in Fig. 1. These panels are supported by legs bolted to the top of the panels, as shown at A. When the panels are set up, the legs are pulled out, so as to brace up the fence, as shown in Fig. 1.

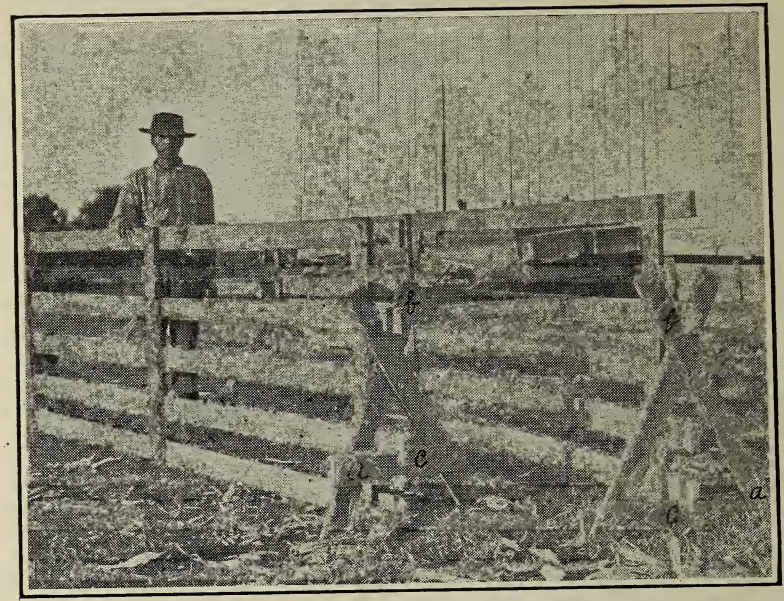
Two men can load this fence on a wagon and move it where needed. Shorter or longer panels may be made, to suit the convenience of the builder.

A panel of fencing of this pattern will cost as follows:

42 feet of lumber, at $18.00 per M	$ .75
A carpenter, at $2.00 per day, should build 18 panels, or, per panel	.11
3 bolts and nails, about	.15
Total cost per panel of 14 feet	$1.01
100 feet of this fencing will cost about	$7.00

Another good strong fence is made in panels 12 feet long. Each is composed of five boards four inches wide and nailed to three pieces 1 by 4 inches, by 3⅔ feet long, as shown in Fig. 2. This makes a fence 4 feet high when set up.

These panels are set in triangular frames, which serve as legs The frames are made by crossing two pieces of boards 3½ feet long, about 6 inches from the top and nailing. They are then braced across the bottom by nailing a piece two feet long, as



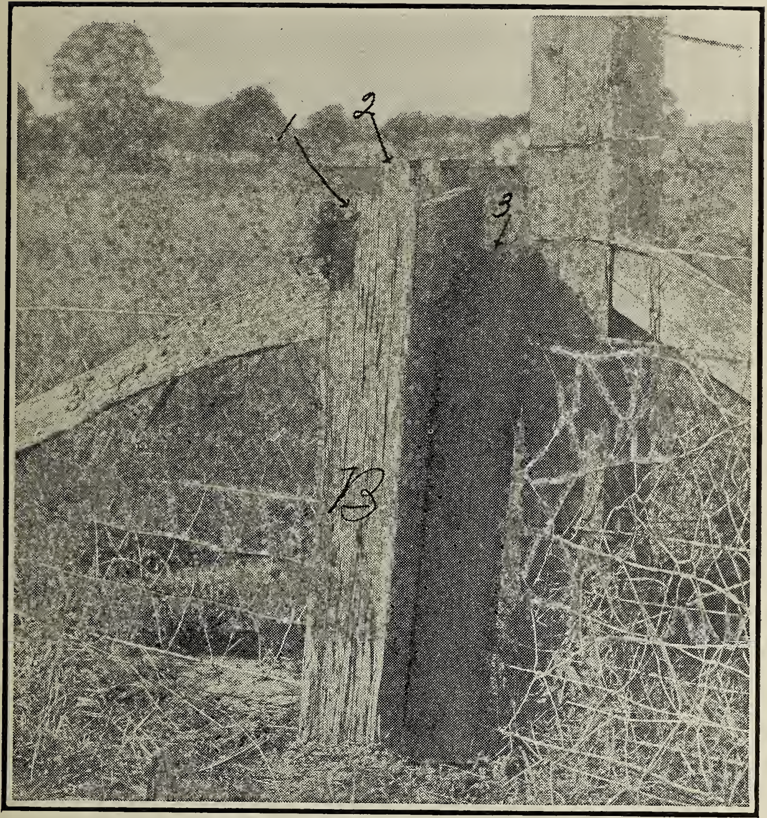
FENCE PANELS.

shown at A, Fig. 2. A two-inch notch is cut at B, and in the center of the brace below at C, which holds the panels in place when set up. The wider the spread of these legs at the bottom, the stronger the fence will be. This fence can be braced down if necessary by driving a one-inch board 18 inches long in the ground near the center of the panel, nailing the panel to it. The fence will be securely held in place.

In a panel of this fencing, including legs, there are 26½ feet of lumber. At $18.00 per M. feet, this would cost 48 cents. A carpenter, at $2.00 per day, can build 20 panels, 12 feet long, which will make the panels, with nails, cost about 60 cents each, or about $5.00 per 100 feet.

The above fences may be used for cattle as well as hogs. Where hogs alone are to be pastured, a fence 30 inches high will answer.

For a temporary partition fence for hogs, a plain woven wire 26 or 36 inches high is perhaps the best and cheapest. This will turn hogs as long as feed is plentiful. If cattle are to be pastured in the same field, one or two barbed wires may be used above the netting.



ARRANGEMENT OF POSTS

For convenience in moving the wire, and at the same time protecting the wire and post, the following method should be used: set two posts in each hole at the ends of the line; set deep enough to hold the wire when stretched tight, which will be not less than four feet deep. In setting the posts leave a space of one inch between the two, as shown in Fig. 3. When ready to stretch the wire, run the end between the posts and hold it in position by bolting two pieces of 2 by 4 on the end of the wire, with the wire between them. Then pass the wire between the posts at the other end of the line, stretch as light as desired, and bolt two other pieces on the wire close up behind the posts. Then remove the stretchers and the wire is held as tight as if nailed.

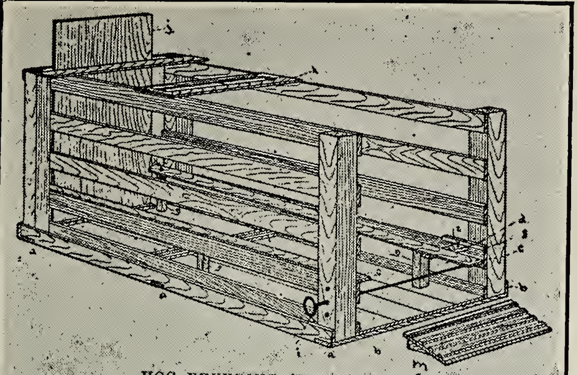
Light posts may be driven every 15 or 20 feet between these corner posts to hold the wire up. If hard posts are used the staples should not be driven up so they can not be easily pulled when one desires to move the fence. To move the wire the staples are pulled out of the post, and the 2 by 4 removed from the ends, when the wire can be rolled up and moved where desired. One hundred feet of this fencing should not cost more than $2.50 or $3.00.

When one plans beforehand for pasture crops, it may be possible to arrange the crops in fields where the length would greatly exceed the width, and in pasturing off the crop use portable fences across the narrow field, at very little cost or inconvenience.

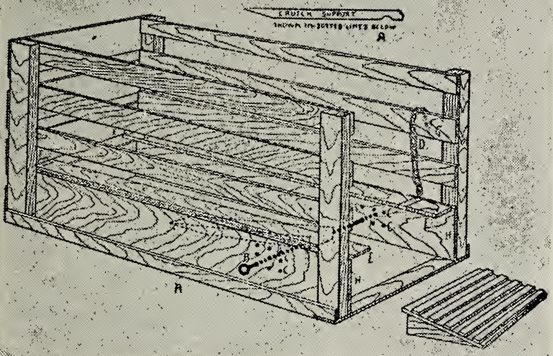
BREEDING CRATES FOR HOGS.

The dimensions of the box (Fig. 1) are: length, 5′ 6″, width 2′ and height 3′. The length of the short box, which may be made by moving the end board j into the slot k, is 3′ 6″. The corner posts are 2″ x 4″ scantling and the sides 1″ x 4″ strips; a a a are joists for nailing the floor to; b b extra boards to which the joists are nailed to stiffen the sides of the box; c c are boar supports which hold the boar's weight during service. The one on the left is stationary, while the one on the right is adjustable to the size of the sow and should fit up tight against her side; d is a piece used to adjust the right-hand support; e is a pin which holds the support in place; f is a strip to hold d in the groove or mortise; the g's (of which there are six) are pieces that hold the supports solid and are 13″ in lentgh; h is a woooden screw to hold the front end of the adjustable support in place; i is a 7/8″ rod which is placed behind the sow to keep her from backing out of the box; j is a movable end board which is used to adjust the box to different length sows. When long sows are to be bred the board is placed in the end of the box, as shown in the diagram, and when the short sows are bred the board is removed and placed in the slotted board k. L L are cleats which hold the bottom end of the board j in place; m is a platform used to raise a small boar high enough to serve a large sow.

The accompanying illustration, shown in Fig. 2, is of the improved type. Instead of the adjustment for long and short sows being handled from the front of the crate that end is made stationary. Put in lower sideboards 10″ high through which



HOG-BREEDING CRATE.—FIG. 1.



AN IMPROVED TYPE OF HOG BREEDING CRATE.—FIG. 2.

holes are bored at convenient intervals (C C C C) to admit the iron rod B, which should pass close under the hams of the sow just above the hocks. The proper hole to use is determined by the size of the sow. A crotch support A is added with a notch in it which passes between the sow's hind legs and rests on the retaining rod, as shown. This is 2″ x 4″ x 3′ long, and the upper edges are rounded off smooth, so as not to injure the sow. The side supports for the boar E are made adjustable by hinging to one of the cross slats in front and are raised or lowered from the back by means of a chain (O) which passes over the top of side board, and fastens to a pin or heavy nail G. Put a chain on for each support. Two 4″ boards, 6″ apart, should be nailed over the top of the crate above where the sow's head comes to prevent her from climbing out.—*Courtesy of Breeders' Gazette.*

THE SCHULER METHODS OF CURING PORK ON THE FARM.

Col. Chas. Schuler, State Commissioner of Agriculture and Immigration, has, for years, employed the following methods of curing pork on his farm with such success that we take the liberty of reproducing them here:

When hogs are fat, select any time during the month of December, January or first half of February, when weather is clear, wind from the north to northwest, with the thermometer registering below 35 at sunrise. Have your water hot and scald as soon as hog is dead. Hang up and disembowel the animal just as soon as it is cleaned. No butchering animal should ever be permitted to cool off until after it is disemboweled. Cut up the carcass as soon as it is through dripping. Saw or split the backbone. Let it and the spare rib remain on the side, and make them as long as you can. Hams and shoulders small. Hams to sell readily should weigh from fifteen to eighteen pounds. Jowl will mix very nicely with trimmings and shoulder in making sausage, either for house use or the market. Feet, when cleaned properly, and put, raw, in strong brine, will keep all right for several months. Spread the joints and sides in your smoke house, applying a small quantity of salt to each piece. Let it lay until next morning to cool, then pack away, using plenty of clean salt.

To Sugar Cure Hams.—To half bushel fine salt add half pound pulverized saltpeter, one pound finely ground black pepper, four pounds brown sugar, mix thoroughly. Rub hams with mixture. Pack in box, skin side down. Apply double handful of mixture to flesh part of each ham. Then apply plenty of clean salt, never permitting the meat to touch, without salt being between. Covering all parts and filling every crevice, and let them remain in the salt six weeks.

How to Smoke Ham.—After being in salt six weeks, select a clear day, string each ham, and dip in a boiling solution of one pound borax dissolved in fifteen gallons of water and hang up high in a dark smoke house (the higher the better) and smoke, using green hickory wood. Smoke daily for two weeks or more, as preferred. By April 1 at latest, hams should again be dipped in boiling water, to cleanse them from all impurities, wrapped in paper, then cloth, and this painted with some cheap mineral paint. Hang up again and leave until used or sold.

To Make Good Sausage.—Grind your meat as fine as possible; don't have it too lean. Season with salt, ground black pepper, a good supply of pulverized soda crackers, not too much sage, and some red pepper tea. Well mix and stuff in sausage cases Cases can be secured from packing houses.

Louisiana Bulletin No. 125. January, 1911

Agricultural Experiment Station

OF THE

Louisiana State University
and A. & M. College

BATON ROUGE

THE BACTERIAL DETERIORATION OF SUGARS

BY

WM. L. OWEN, B. S., BACTERIOLOGIST

1911
RAMIRES-JONES PRINTING CO
Baton Rouge, La.

AGRIC. EXTN. LIBRARY
LOUISIANA STATE UNIVERSITY

Louisiana Bulletin No. 125. January, 1911.

Agricultural Experiment Station

OF THE

Louisiana State University
and A. & M. College,

BATON ROUGE

THE BACTERIAL DETERIORATION OF SUGARS

BY

WM. L. OWEN, B. S., BACTERIOLOGIST

Ramires & Jones,
Baton Rouge, Louisiana.
1911

Louisiana State University and A. & M. College

Louisiana State Board of Agriculture and Immigration

EX-OFFICIO.

GOVERNOR JARED Y. SANDERS, *President.*
HENRY L. FUQUA, *Vice-President of Board of Supervisors.*
CHAS. SCHULER, *Commissioner of Agriculture and Immigration.*
THOMAS D. BOYD, *President State University.*
W. R. DODSON, *Director Experiment Stations.*

MEMBERS.

R. S. MOORE, St. Bernard.
HENRY GERAC, Lafayette.
JOHN T. COLE, Monroe.
JOHN J. HENDERSON, Lagan.
R. E. THOMPSON, Wilson.
JEFF D. MARKS, Crowley.
J. E. BULLARD, Belmont.

STATION STAFF.

W. R. DODSON, A. B., B S., Director, Baton Rouge.
HAMILTON P. AGEE, B. S., Assistant Director, Audubon Park, New Orleans.
S. E. McCLENDON, B. S., Assistant Director, Calhoun.
FRIEND C. QUEREAU, M. S., Ass't Director, Rice Exp. Station, Crowley.
W. E. CROSS, Ph. D., Chemist, Audubon Park, New Orleans.
W. G. TAGGART, B. S., Assistant Chemist, Audubon Park, New Orleans.
R. E. GRAHAM, B. S., Assistant Chemist, Audubon Park, New Orleans.
WM. L. OWEN, B. S., Bacteriologist, Audubon Park, New Orleans.
J. K. McHUGH, Secretary and Stenographer, Audubon Park, New Orleans.
J. E. HALLIGAN, B. S., Chemist, Baton Rouge.
A. P. KERR, M. S., Assistant Chemist, Baton Rouge.
R. BAUS, B. S., Assistant Chemist, Baton Rouge.
R. G. FULLER, B. S., Assistant Chemist, Baton Rouge.
R. G. TILLERY, M. S., Assistant Chemist, Baton Rouge.
P. H. DOHERTY, B. S., Assistant Chemist, Baton Rouge.
G. D. CAIN, B. S., Assistant Chemist, Baton Rouge.
ROGER P. SWIRE, Treasurer, Baton Rouge.
J. B. GARRETT, B. S., Entomologist, Baton Rouge.
G. L. TIEBOUT, B. S., Horticulturist, Baton Rouge.
W. H. DALRYMPLE, M. R. C. V. S., Veterinarian, Baton Rouge.
C. W. EDGERTON, Ph. D., Plant Pathologist, Baton Rouge.
E. W. KERR, M. E., Professor Mechanical Engineering, Baton Rouge.
H. A. NADLER, B. S., Assistant Mechanical Engineering, Baton Rouge.
T. C. PAULSEN, B. S., M. D. C., Assistant Veterinarian and Bacteriologist.
J. T. TANNER, B. A., Secretary and Stenographer, Baton Rouge.
WALTER McCLENDON, Farm Manager, Baton Rouge.
EWELL CAMP, Mailing Secretary, Baton Rouge.
IVY WATSON, Farm Manager, Calhoun.
E. J. WATSON, Horticulturist, Calhoun.
HENRY STAPLES, in charge of Dairy, Baton Rouge.
T. J. WEAVER, Gardener, Baton Rouge.

CONTENTS.

INTRODUCTION.

I. THE BACTERIAL FLORA OF SUGARS.
- (1) Methods of Isolating Species.
- (2) Gum-forming Organisms previously described.
- (3) Table of Biochemical Characteristics.
- (4) Table of Cultural Characteristics.
- (5) Resistance of Spores to Heat.
- (6) Resistance to Formaldehyde.

II. THE RESULTS OF EXPERIMENTS ON DETERIORATION OF SUGARS.
- (1) Plan of Experiments.
- (2) Method of Sterilizing Sugars.
- (3) Method of Inoculating Sugars.
- (4) Description of Inoculating Apparatus.
- (5) Results from Inoculation of Sugars.
- (6) Table showing Results from the Deterioration of Sugar Samples.
- (7) Error in Clerget Determination of Sucrose caused by the presence of Levan.
- (8) Clerget Method of Sucrose Determination compared with Invertase Method.

III. THE NATURE OF THE BACTERIAL DETERIORATION OF SUGARS AND THE CONDITION AFFECTING THIS ACTION.
- (1) Theory of the Nature of the Bacterial Deterioration of Sugars.
- (2) Theory of the Origin of the Gum developed by the Bacteria occurring in Sugars.
- (3) Influence of Concentration of Sucrose upon Gum Formation.
- (4) Influence of Reducing Sugars upon Gum Formation.
- (5) Influence of Dextrose and Levulose upon Gum Formation.
- (6) Influence of Peptone upon Gum Formation.
- (7) Influence of Chlorides upon Gum Formation.
- (8) Influence of Aeration upon Gum Formation.
- (9) Influence of Duration of Inoculation Period upon Gum Formation.
- (10) Isolation of Gum-Forming Enzyme.
  - (1) Levanase, the proposed name of Enzyme.
  - (2) A newly discovered Decomposition of Sucrose.
- (11) Influence of Nascent Levulose and Dextrose upon Gum Formation.
- (12) Gum formation in Solution without addition of nutrient elements.
- (13) Gum Formation in Bouillon.

IV. PRACTICAL APPLICATION OF RESULTS, AND CONCLUSIONS.
- (1) Results of Bacteriological Control of a Sugar House.
- (2) Results of Bacteriological Control of a Refinery.
- (3) Practical suggestions.

The Bacterial Deterioration of Sugars.

INTRODUCTION.

The question of the deterioration of sugars in storage has formed the subject of many investigations both in the cane and beet sugar industries in recent years, and has also occupied the attention of the sugar planter since it has come to be generally appreciated as a source of considerable loss. It is probable that the loss to the industry through this source was suspected long before scientific investigation had established it as an actual fact, and probably before the nature of the causes of this change in sugars had been apprehended. For a long time the popular idea regarding the deterioration of sugars was that this action was due to certain changes which might be termed autogenous—that is, those changes independent of outside influences. As an example of this theory, we might take the idea that the slow deterioration of sugars is caused by the hydrolytic action of the organic acids which they contain. Later, however, this view was modified and the theory of the indirect inversion of sugar by bacteria became a popular one. By this indirect inversion is meant that which is due to the action of the acids developed by the micro-organisms occurring in sugars. One of the principal factors that have operated against an earlier solution of the problem is the difficulty of determining whether an apparent case of deterioration, as indicated by a fall in the polarization of a sugar, is due to any real decomposition of the product, or is only the result of a lack of uniformity of sampling. This has applied particularly to sugars that have been stored for considerable periods of time, and where the variation in the moisture content has not been accurately recorded.

Under these conditions it has been natural to attribute any change in the polarization of sugars to a change in their moisture content, while in the light of our present knowledge we have reasons to believe that many of such changes are due to real deterioration in such products. Another factor that has very likely delayed the solution of the problem and led us to least suspect the true cause of the deterioration of sugars is that this material has hitherto been regarded as a highly unfavorable nutrient medium for micro-organisms in general. Both on account of its lack of the nutrient elements essential to the development of micro-organisms, and its comparatively low moisture content, we have hitherto classed sugars among those substances that are not at all subject to such action. In addition, moreover, to these conditions of sugar, which would ordinarily lead us to regard it as free from the action of micro-organisms, its physical condition would seem to preclude their development owing to the high concentrations of the solution surrounding the sugar crystals. In view of the many conditions lacking in sugar to fulfill the requirements of the great majority of bacterial species, the discovery of certain species which have adapted themselves to these unusual conditions for bacterial development is of interest even considered apart from the economic importance of the changes that they induce. For, with the knowledge of this adaptation of bacteria to environments highly unfavorable to their development, as viewed from the standpoint of what we have hitherto regarded as essential to it, we are compelled to believe that the range of bacterial activities is far wider than we have thought them. If those species of bacteria which have been found to be the causative agents in the deterioration of sugars have become so well adapted to the environments of a relatively non-nitrogenous material as to have their nutrient demands sufficiently well satisfied in a 97% sugar as to enable them to propagate and carry on their metabolic activities, it would seem that many of our known species might as readily become adapted to less favorable nutrient media than what we have hitherto supposed was essential for their development. And this supposition is the more strikingly suggested in this particular case because the organisms constituting the bacterial flora of sugars are species well known to bacteriologists, but which prior to the discovery of their new environment were not accredited with any distinctive properties regarding their nutrition requirements. For their cultivation upon artificial culture media we have hitherto thought it necessary to provide them with nutrient elements in much the same proportions as is used for general work, and would not have thought that less elaborate substrata would suffice for their development.

In reviewing the literature upon the subject of this work we find that one of the earliest investigations was conducted at this station in 1902. This work (*), "Relation of Bacteria to the Inversion of Crystallized Sugars," though purporting to be only a preliminary investigation upon the subject, was among the first that conclusively showed the causative relationship between bacteria and the deterioration of sugars. At a much earlier period Shorey (†) had attributed the deterioration of sugar to the action of Pencilium glaucum, the mycelium of which he claimed to have found in raw sugars. This work appeared in 1898. About the same time, or somewhat later, there appeared in the International Sugar Journal the results of an investigation by R. Greig Smith (‡) upon "The Deterioration of Raw and Refined Sugar Crystals in Bulk." This article was a reprint from the proceedings of the Linnean Society of New South Wales, in which the deterioration of sugars was attributed to an organism to which he gave the name *Bac. levaniformans* on account of its power to form levan from sugars. In 1908 there appeared a report (§) of an investigation upon "The Deterioration of Sugars on Storage" by Noel Deerr and R. S. Norris at the Hawaiian Sugar Planters' Station. This report dealt largely with the results of investigations upon the deterioration of sugars in storage with particular reference to the relation between the rate of deterioration and the composition of the sugar. In a subsequent investigation (||), conducted at the same institution by L. Lewton Brain and Noel Deerr, the results of which were embodied in the report entitled "The Bacterial Flora of Hawaiian Sugars," a more intensive study was made of the micro-organisms constituting the flora of sugars and the conditions influencing their action. The above publication appeared in 1908 shortly after the investigation covered by this publication had been instituted at this station. Having briefly indicated the several investigations that led up to the present

---

*Relation of Bacteria to the Inversion of Crystallized Sugars, W. R. Dodson, Bulletin 75, Louisiana Experiment Station.

†The Deterioration of Sugar by Pencilium glaucum. Jour. Soc. Chem. Ind., Jan., 1898.

‡The Deterioration of Raw and Refined Sugar Crystals in Bulk. R. Greig Smith, reprint from Proc. Linnean Soc. of New South Wales.

§The Deterioration of Sugars on Storage. Noel Deerr and R. S. Norris, Bulletin Hawaiian Sugar Planters' Station.

||The Bacterial Flora of Hawaiian Sugars. Lewton Brain and Noel Deerr, Bulletin Hawaiian Sugar Planters' Station.

work, it might be well to comment upon the extent to which conclusive data upon the subject had been adduced at the time of the inception of our investigation.

The causes of deterioration of sugars had been conclusively shown to be due to the action of bacteria, although the identification of these species had not been thoroughly worked out. Some of the conditions influencing the bacterial deterioration of sugars had also been studied to the distinct advantage of pointing out certain factors that tended to make certain sugars more susceptible to this action. With the knowledge of the advances that had been made in the subject, the present investigation was planned with the purpose of making a thoroughly comprehensive study of the problem and contemplating an equally intensive study of the underlying causes of the phenomenon in all of its phases. It is only such knowledge as that deduced from investigations which seek adequate explanation of the many factors influencing a phenomenon, with the proper coordination by which they are assigned their true value, that the success of the practical application of this knowledge is assured. Realizing this fact, the author has sought in these investigations to explain the phenomenon of the bacterial deterioration of sugar in all of its phases by detecting all of those influences offered by the many conditions represented in the various products subject to this action. As is so frequently the case in any investigation, many important points of research have been suggested by the results of the experiments, but these were not considered essentially pertinent to the phase of the investigation that was desired to be stressed. These have therefore been reserved for future investigations which will naturally follow from the inevitable demands for this extended knowledge upon the subject after the fundamental principles of the subject have attained general recognition.

The author of this publication desires to acknowledge profound gratiude for the assistance that he has been rendered by a number of parties in their various capacities, all of which assistance has contributed materially to the degree of success that has attended the investigation in all of its stages. The sincere thanks of the author are due Director W. R. Dodson, who proposed the investigation and who offered many helpful sug-

gestions in its prosecution; to Assistant Director H. P. Agee, whose wide familiarity with the sugar industry enabled him to give much helpful advice regarding many valuable practical aspects of the investigation, and to Assistant Chemist W. G. Taggart, to whom was intrusted the greater portion of the analytical work required in the investigation and whose untiring efforts and exceptionally painstaking analytical determinations, together with his resourcefulness upon all occasions, cannot be overestimated in their value as one of the material contributions to the success of this work. Thanks are also due Mr. D. D. Colcock, of the New Orleans Sugar Exchange, for his many favors in donating samples of sugars to this department, and to Mr. J. A. Hall, Jr., formerly of the New York Sugar Trade Laboratory, for similar service. The author is indebted to Mr. A. W. Drinkard, Jr., of the Virginia Experiment Station, for his kindness in furnishing the photomicographs for the publication, and to Mr. T. C. Barber, of the Bureau of Entomology, U. S. Department of Agriculture, for the other photographs appearing therein. The author is also indebted to Dr. P. A. Yoder, formerly of this station, for his kindness in aiding in the search of literature on the subject and assisting in certain translations from foreign publications. Thanks are also due Dr. W. E. Cross, research chemist of this station, for services of a similar nature, and for his many kind suggestions in the prosecution of this work.

The Bacterial Deterioration of Sugars.

CHAPTER I.

THE BACTERIAL FLORA OF SUGARS.

In order to properly ascertain the relation of bacteria to the deterioration of sugars it is necessary to determine the species that cause this action, and to thoroughly study their morphological and physiological characteristics for the purpose of identifying them as known species or of learning of their distinctive biological activities. We need to know the potential of each species in its relation to the deterioration of sugar before we can understand the significance of its presence in such products in regard to the changes that it is likely to bring about. It is obviously of first importance that we direct our attention to the investigation of the bacterial flora of sugars for the purpose of ascertaining the species that induce the deterioration of these products, for only by this knowledge can we intelligently anticipate the factors that must be considered in the general investigation. If there are a large number of species associated with this phenomenon and sugars from different sources and of different compositions vary widely in their bacterial content, the problem will in that case be the more complicated since the relation between each species and its favorite product must be established. If, on the other hand, only a few species are found to constitute the bacterial flora of sugars and these species occur in all such products that are capable of supporting bacterial life, the problem is greatly simplified since it is only necessary in that case to ascertain the potential of each species to induce the deterioration in question. In the premises of the case it seems conceivable that only comparatively few species would be found that have become adapted to this unusual habitat, so in this respect this part of the investigation has not required a very large amount of time or attention. It was greatly to be desired, however, that we should plan our studies of this subject in a manner that would insure adequate data upon the species associated with the phenomenon in order that our experimental results might be applicable to general conditions in the industry. If the species which we isolated for study had not been representative of the bacterial flora of sugars the results from our experiments in testing their action upon such products might not have sufficed as an explanation of the various degrees of deterioration that different sugars undergo. With the view of making a thorough study of this subject a large number of samples of sugars were procured for the work. This collection of samples embraced sugars from all parts of the world, represesenting various methods of manufacture and all the influences of varied climatic conditions. It was thought that a thorough study both of the species occurring in these sugars and of the rate of deterioration would afford the desired data upon the subject, enabling us to arrive at definite conclusions regarding the number of species constituting the bacterial flora of such products and the factors that influenced their action. The sugars were placed in desirable containers, which were ordinary fruit jars that were provided with very closely fitting covers, and their chemical analyses and bacterial content were recorded in a note-book kept for that purpose. With these records of the analyses of each of the sugars, which were made monthly, the deterioration of any of the samples would suggest special investigation of its bacterial content. In conjunction with these studies, however, others were undertaken consisting of inoculating sterile sugar solutions with small portions of the samples and in this way determining whether the species occurring in the different sugars were capable of inducing the decomposition of sugar in solution. After this work had progressed for a comparatively short time and all of the samples in the collection had been somewhat thoroughly studied in this manner it was noticed that all of the sugars that were found by analysis to be deteriorating would when introduced into the solutions used for this purpose induce a similar deterioration, thus establishing the reliability of the method. The species isolated from the sugars were propagated upon sucrose agar and their properties studied with minuteness, both as regards their cultural and physiological characteristics. The following methods were employed in the isolation of the species from sugars: small portions of the samples were taken up by a sterile platinum loop and transferred either direct to liquid agar in tubes, from which they were poured into petri dishes, or to tubes containing Greig Smith's sucrose solution, where they were allowed to develop before plating out. Where the number of the organisms per gram in the samples was to be ascertained, the gravimetric method was employed, by which half gram portions were weighed out in sterile plates and then transferred to tubes containing 25c.c. of sterile water, from which ½c.c. portions were usually transferred to agar tubes making a dilution of one to one hundred. The degree of dilution practiced, however, was varied for the different grades of sugars, as it was found to be too low in certain cases for low grade sugars, and too high for the higher grades, but after a little plating work had been done the bacterial content of a sugar could be anticipated in most cases and the dilution so regulated as to render the counting of colonies an easy matter. In the first stages of this work the widely dissimilar colony development upon the plates inoculated from the sugar samples indicated an almost bewildering number of species, while the morphological characteristics of the organisms from these colonies appeared as surprisingly similar. With the exception of certain cases where involute forms occurred the prevalent organisms were bacilli of varying dimensions, but with the same staining properties and general morphological characteristics. The species observed were almost exclusively spore formers, and all were stained by Gram's stain. Where the sugars were transferred direct to the agar tubes the presence of involute or degenerate forms in the colonies that developed upon the plates seemed of some significance. These forms are very often to be observed on old cultures, and usually indicate either an exhaustion of the nutrient elements of the medium or the accumulation of metabolic products which render the medium unfavorable for the continuation of normal cell development. The occurrence of these forms in cultures from 18 to 24 hours old is therefore not to be explained by either of the above factors, as we would hardly suspect either so rapid an exhaustion of the food supply by the organisms composing the colonies on the plate, or an accumulation of products from the metabolism of the organisms that would so promptly exercise so marked a restrictive action. In order to prove this point inoculations were made from cultures that had been grown for some time on agar, to the plates where these involute forms were observed, from which it was found that the colonies developing from such inoculations did not show degenerate forms earlier than 48 hours. The explanation of the early development of these degenerate forms where the agar tubes were inoculated direct from sugars is in all probability that the difference in the density of the film of moisture surrounding the sugar crystals and the medium to which the sugar was transferred tends to produce a swelling of the cell protoplasm when the organisms are transferred to a medium of so much lower density. Through adaptation the species of bacteria occurring in sugars have accustomed themselves to the density of the moisture film, and when suddenly transferred to the culture medium of much lower density develop abnormally as indicated in the forms produced. This phenomenon has been observed with many of the lower organisms (*), which have been found to produce unusual forms when grown in solutions of various densities.

In order that none of the species constituting the bacterial flora of sugars and associated with the deterioration of such products might be overlooked, transfers were made from all of the colonies developing upon the plates appearing in the least distinctive in any particular. The cultural characteristics were made the basis for the isolation of the species, and although it was subsequently discovered in the course of the work of identification that many of the cultures thus isolated were really duplicates, yet this was easily corrected and obviated the possibility of overlooking any of the species occurring in any of the products. After having completed the preliminary work of isolation from the sugar samples on hand all species of bacteria as indicated by slight differences in the colony development upon sucrose agar, there were some fifteen or twenty cultures collected, which were to be further studied as to their complete identificaation. The slight differences in the cultural characteristics of these cultures, which even from the first rendered a differentiation into species somewhat arbitrary, were after a few transfers completely obliterated and as the more important physiological characteristics were identical from the beginning it was found that many of the cultures were duplicates. As the study of the species constituting the bacterial flora of sugars proceeded it was obesrved that three types of bacteria predominated and all of the species were to be classed in one of these types. There were, of course, some species that differed in certain slight particulars from these, but the variation was hardly sufficient to suspect them of being new species, and they were regarded as races of one or the other of the three types. Greig Smith (*) in his study of the bacterial flora of sugars pointed out the affinities of these organisms, to which he gave the name Bacillus levaniformans, with the potato group of bacteria.

---

*Davenport's Action of the Density of the Medium on Protoplasm. Experimental Morphology, Chapter III.

The members of this group are *Bacillus vulgatus, mesentericus fuscus, liodermos* and *mesentericus ruber,* and are very widely distributed in nature, occurring in soil, and, on account of their frequently contaminating potato cultures, by reason of the great resistance of their spores to heat, are known as the potato group. These organisms are further characterized by their ability to form a kind of gum on potato, and in certain cases Bac. vulgatus has been known to induce a slimy fermentation of bread. The spores of this organism doubtless resisting the baking temperature and subsequently germinating and giving rise to the fermentation in question (†). This ability to form gum indicates a relationship between the *Bacillus levaniformans* of Greig Smith's, which induces the gum fermentation in sugar products and the above group of organisms, and Smith, himself claims that the *Bacillus levaniformans* is related to the group as a whole, but sufficiently distinctive in its properties to be regarded as a different species. The relation between the organisms isolated from sugars and the members of the potato group is very strikingly indicated in the morphological characteristics, and as the latter are very widely distributed in nature, occurring in soil and upon vegetable matter, it was thought that the organisms found in sugars were really the same species and belonged to the same group. The difference in environment might easily account for the slight differences in the cultural and physiological characteristics, for it might be supposed that the conditions offered by sugars for bacterial development are such as would induce certain changes

---

*Vol. XXVI, Linnean Society of New South Wales.
†Fischer's Vorlesungen Ueber Baktericy, p. 62.

in the organism. As one of the distinctive properties of the organism is its ability to form gum levan from sugars, it was decided to test for the possession of this property by those of the potato group representing the prevalent types found in sugar products. The two types of most general occurrence very strikingly simulate the *Bac. mesentericus vulgatus* and the *Bac. mesentericus fuscus,* sometimes called the mesentery bacilli owing to the striking resemblance of their growths on potato to the mesenteries. These two species were therefore isolated from soil and kept for a comparative study in order to determine their ability to form levan from sugar, and to see if the differences in cultural characteristics as observed when first isolated from the two sourecs, would disappear after they had been grown for a time under identical influences. It was found that the species isolated from soil would, when inoculated into a sugar solution, induce the gum fermentation almost as vigorously as those which had been separated from sugars. Continued transfers also tended to equalize this property as well as to cause a convergence of the cultural characteristics which differed to some extent at the beginning, and, although some slight differences were always to be observed, this was not greater than is sometimes met with in variations of the same culture. It is but fair to assume therefore that the organisms that have been found to be associated with the deterioration of sugars are derived forms of the potato group of bacteria, which are noted for the very high resistance of their spores to heat. It is on account of this property that the species occurring in cane juices are enabled to withstand the temperature of the manufacturing process and to persist throughout the successive stages, thus forming the contamination of the finished sugar. Lafar claims (*) that the spores of the potato bacilli can withstand the temperature of streaming steam for six or seven hours, thus making it the most resistant of bacterial species. The very high resistance of the species occurring in sugars still further suggests the relationship between the two groups.

The bacterial species constituting the bacterial flora of sugars may be grouped in three divisions according to their morphological and physiological characteristics, and these groups may be properly represented by the *Basillus vulgatus,* the *Bacillus mesentericus fuscus,* and a bacillus form much larger than either of these species, which is very probably the *Bacillus megatherium.* The *Bacillus mesentericus vulgatus* type is more prevalent in sugars than the other two, and so far as has been observed is more active in bringing about the deterioration of sugar products.

---

*Techniche Mycologie.

In addition to the three above-mentioned types which occur most frequently, *Bacillus liodermos, Bacillus mesentericus niger,* and *Bacillus granulatus mesentericus,* all members of the potato group, are sometimes found. These species are doubtless derived forms of the more commonly found types, *Bac. vulgatus* and *Bacillus mesentericus fuscus.* In one instance we have met with *Bacillus niger,*but it seems rarely to occur in sugar products.

As the principal characteristic of the bacteria associated with the deterioration of sugars is their ability to form gum in sucrose solutions, it might be interesting for us to review briefly the literature describing certain gum-forming bacilli. Marshall Ward and Reynolds Green (*) isolated an organism which had the power of forming gum from sugar solutions. The organism was a bacterium and worked in symbiotic relationship with a yeast, the two forms occurring as excrescences on sugar cane and forming in sugar clumps strikingly resembling the ginger beer plant. The bacterium can only induce this gum fermentation when the yeast is present, or if at all the action in the absence of the yeast is very feeble. The yeast is equally dependent upon the bacterium in bringing about the fermentation. The gum formed by Ward's Sugar Bacterium, though not identical with Scheibler's dextran, seems very closely related thereto. The presence of sucrose was found to be essential to the formation of gum, and though other sugars and also starch were experimented upon, in no case was gum formed in the absence of sucrose. The symbiotic relationship between the bacterium and the associated yeast, and the nature of the gum formed clearly differentiates this species from those met with in our investigation.

Fritz Glaser (†) isolated from beet juice a bacterium which resembled in certain respects *Leuconostoc mesenteroides* and formed a gum that was essentially the same as that formed by the latter organism. Fritz Glaser's *Bacterium gelatinosum betae* differs from the Leuconostoc of Zopf's in the products of its fermentation as it forms alcohol instead of lactic acid, as in the case of the latter organism. It further differs from the latter organism in the conditions under which it forms gum, as the latter will form dextran in ten per cent neutral molasses, while Fritz Glaser's organism would produce no gum under these conditions. According to the author, no spores were observed in his investigation of the bacterium, though the temperature that it withstands would indicate that it was a spore-forming organism. It is probable that this organism is closely related to the potato group of bacteria.

---

*Green's Proceedings of the Royal Society of London, Vol. LXV, 1899, pp. 65-85.

†Centrablatt fuer Bakteriologie und Parasitenkunde Abt. 2 Vol. I, 1895.

Ritsert (*) isolated from a digitalis infusion a bacterium to which he gave the name *Bacterium gummosum,* owing to the property that it possessed of forming gum in sucrose solutions. It was found in the case of this organism as with the others that have been here described that the formation of gum took place only where sucrose was present. Experiments on grape and milk sugar gave negative results. The author found that the formation of gum took place in solutions of sucrose of as high concentration as 60% with an optimum concentration of 20%. He describes an interesting case of pleomorphism in connection with his organism, stating that it sometimes occurred as long anthrax-like rods, streptococus or diplococus forms depending upon the nature of the medium in which it was grown. The organism was Gram negative and formed endogenous spores.

Happ (†) also isolated from digitalis infusion an organism which he named *Bacillus gummosus.* This organism was associated with a slimy fermentation of the digitalis and is described as a large feebly motile bacillus, liquefying gelatine and forming spores. The acids of its fermentation are butyric and lactic.

Another species that is also very probably related to the potato group of organisms is the *Bacterium mesentericus panis viscosus,* or the organism of stringy bread. This is a Gram positive organism and somewhat resembles the *Bacillus mesentericus fuscus* in its cultural characteristics. It has already been noted that the members of the potato group of bacteria are sometimes associated with the slimy fermentation of bread, so it would seem that this organism may be a race of one of the members of that group.

---

*Ber. der Deutschen Pharmazeutischen Gesellschaft, Band 11, 1891.

†Happ. Cent. Bakteriologie und Parasitenkunde, Vol. XIV, 1893, p. 175.

It seems probable that all of the gum-forming organisms above described are derived types of the potato group of organisms, and are in reality only races of those species. The different environmental influences may very well account for certain of the slight differences in the cultural characters.

The fact that the potato group of organisms and the species above described and those constituting the bacterial flora of sugar products have so many common characters and since they are all characterized by their ability to form gum from sugar, it is more than likely that they are closely related species.

THE BACTERIAL FLORA OF SUGARS.

In the following table the most important biochemical characteristics of the organisms are recorded. From this table it will be seen that all of the species are Gram positive in their staining action, and that they are spore formers and gelatine liquefiers. They vary to some extent in the relative rate of their action upon gelatine, some causing liquefaction very quickly, while others act very slowly. They may be divided into three groups upon the basis of their morphological and physiological characters. These three groups would be represented by the *mesentericus vulgatus* type, the *mesentericus fuscus* type, and the *megatherium* type.

The different types mentioned in the table are to be regarded as races of the species for which they are named. As their most important characteristics are identical, it is most likely that the differences in cultural characteristics are due to the environmental influences to which they were subjected. It is very likely, for instance, that the influence of the environment of sugar crystals would have a tendency to make their characteristics different from what they would have been under the environmental conditions offered by a syrup or molasses. As the different species were isolated from many different sources representing greatly divergent environmental influences, it was very likely that their culture characteristic was due to this difference. This classification was easily made upon the basis of

SPECIES	Reaction to Gram's Stain	Formation of spores	Liquefaction of gelatine	Fermentation of Levulose		Fermentation of Dextrose		Gum Fermentation of sucrose		Production of Indol	Production of hydrogen sulphide	Growth in albumen (free medium)	Source	Size in microns	Presence of flagella	Film on bouillon	Growth in closed arm
				Acid	Gas	Acid	Gas	Dextran	Levan								
Bac. vulgatus (A)	+	+	+ R	+	—	+	—	—	+	+	....	+	Sugar	L. B.	+	+	—
Bac. vulgatus (B)	+	+	+ R	+	—	+	—	—	+	+	....	+	Sugar	L. B.	+	+	—
Bac. vulgatus (C)	+	+	+ S	+	—	+	—	—	+	+	....	+	Sugar	L. B.	+	+	+
Bac. vulgatus (D)	+	+	+ S	+	—	+	—	—	+	+	....	+	Sugar	L. B.	+	—	+
Bac. mes. ruber	+	+	+ S	+	—	+	—	—	+	+	....	+	Sugar	L. B.	+	+	+
Bac. mes. fuscus	+	+	+ S	+	—	+	—	—	+	+	....	+	Sugar	L. B.	+	+	—
Bac. mes. fuscus (A)	+	+	+ S	+	—	+	—	—	+	+	....	+	Sugar	L. B.	+	+	—
Bac. mes. fuscus (B)	+	+	+ S	+	—	+	—	—	+	+	....	+	Sugar	L. B.	+	+	+
Bac. mes. niger	+	+	+ R	+	—	+	—	—	+	+	....	+	Sugar	L. B.	+	+	—
Bac. liodermos	+	+	+ S	+	—	+	—	—	+	+	....	+	Sugar	L. B.	+	+	+
Bac. mes. granulatus	+	+	+ R	+	—	+	—	—	+	+	....	+	Sugar	L. B.	+	+	+
Bac. gummosus	+	+	+ R	+	—	+	—	—	+	+	....	+	Sugar	L. B.	+	—	—
Bac. megatherium	+	....	+ R	+	—	+	—	—	—	+	....	+	Sugar	L. B.	+	—	—
Bac. sacchari	+	....	......	....	....	....	....	+	—	+	....	+	Cane juice	L. B.	—	....	....

SPECIES	PLAIN AGAR	SUCROSE AGAR	GELATIN	POTATO
Bac. vulgatus (A) Long, slender rods, ends scarcely at all rounded. Occur singly and in chains. Stain by Gram's method, and uniformly stained by alcoholic sol. of aniline stains. Endospores produced. Isolated from Sugar No. 78.	Plate. — Small, round, slightly elevated white colonies, edges lighter in color than interior of colony. Interior structure amorphous. Streak.—Greyish white growth, confined to needle track, tending to be dry and crumbly. Water of condensation clouded with strong film. Stab. — Greyish white surface growth, line of puncture filiform.	Plate. — Large, round, irregular shaped, elevated, glistening colonies. The top of colonies appear particularly glistening. In color colonies are greyish white. In shape colonies appear like oyster shells. Streak. — Transparent, spreading growth, covering entire surface of medium. The growth is moist and glistening, edges irregular; water of condensation clouded, no film.	Plate. — Large, round and irregular shaped transparent colonies. Appear like drops of moistuer on surface. Medium liquefied quickly. Film formed on liequefied area. Stab.—Medium quickly liquefied line of puncture at first sacchate. No film formed on liequefied area.	Very vigorous growth, which at first appears typical mesentery. Growth later becomes a homogeneous, gummy mass, covering entire surface of potato. Growth very variable.
Bac. vulgatus (B) Long rods as above except ends more rounded and cells slightly larger. Stain by Gram's method. Endospores produced. Isolated from Sugar No. 70.	Plate. — Small, round, elevated whitish grey colonies. The colonies appear granular and are easily detached from surface of medium as a sheath or membrane. Streak.—Same as A, except growth is slightly whiter. Condensation water clear. Strong film. Stab. — Dry granular growth, line of puncture filiform.	Plate.—Small, irregular shaped flat colonies, white with slightly fringed edges. Original colony appears as white point in center. Streak.—White, slightly elevated spreading growth, edges irregular. Condensation water clouded, film formed. Surface of growth slightly granular.	Plate. — Small white colonies, which quickly sink beneath the liquefied area. The colonies are granular. Film formed on surface of liquefied area. Liquefaction rapid, occurring in two days. Stab.—Medium quickly liquefied; strong film formed on surface.	Growth typical of mesentery group. The coils appear somewhat larger and of a darker yellow color than the above.
Bac. vulgatus (C) Long rods, occurring singly, slightly smaller than the other species above described. Isolated from sugar No. 92.	Plate.—Colonies similar to above, except larger and of a darker grey color. Streak.—Same as above, except condensation water clear without film. Stab.—Raised greyish, moist, shining, gummy growth, very faint along line of puncture.	Plate. — Irregular elevated amœboid colonies. Their surface glistening and of a gummy consistency. Light grey in color. Streak. — Elevated transparent growth, surface raised in undulating folds. Condensation water clouded, film formed light.	Plate. — Large, round, elevated, transparent growth. The medium gradually liquefied. Stab. — Medium more slowly liquefied than in above types. Line of puncture fuliform. No film formed on surface.	Growth same as above, except more vigorous. Mesenteric coils slightly larger.

Bac. vulgatus (D) Long rods, larger than previous types. Ends more rounded. Stain by Gram's method. Endospores produced. Isolated from Sugar No. 92.	PLATE.—Small, greyish colonies, flat and round, as in types previously described, though slightly smaller. STREAK.—Flat, spreading, transparent growth, moist and shining. Water of condensation clear, no film. STAB. — Greyish white growth, covering entire surface of medium. Line of puncture fuliform.	PLATE.—Large amœboid colonies, differing from C in the transparency of the colonies. Round colonies are also observed. STREAK.—Raised, transparent, slightly elevated, growth spreading over entire surface. STAB.—Surface smooth. Condensation water clouded; no film.	PLATE.—Large, round, yellowish colonies, under which the medium gradually becomes liquefied in saucer-like depressions. No film on liquefied area. STAB.—Medium is slowly liquefied; no film.	Growth appears as a homogeneous, glistening area. Unlike previously described type.
Bac. mesentericus ruber. Short, thick rods, ends rounded, stain by Gram's method. Irregularly stained by alc. solutions, aniline dyes. Cells occurring singly and in pairs. Isolated from Sugar No. 91.	PLATE.—White, irregular shaped colonies, slightly elevated, edges filamentous. Internal structure floccose. STREAK.—Whitish grey, fatty growth, spreading over entire surface of medium. Water of condensation clear, with loose film on surface. STAB.—Greyish growth, covering entire surface. Line of puncture fuliform.	PLATE.—Large, elevated, moist, glistening growth, of a gummy consistency. The growth spreads over entire plate and is indistinct. STREAK.—Raised, spreading, transparent growth. Surface very irregular. Edges filamentous. Water of condensation thickly clouded; no film.	PLATE.—Large, round, greyish, felt-like colonies. Medium liquefied as a saucer-shaped depression. STAB. — Medium liquefied slowly in the form of a crateriform depression.	Entire potato colored deep red. Raised portion of growth resembles *Bac. mesentericus fuscus.*
Bac. mesentericus fuscus. Short, thick rods with rounded ends occurring singly and in pairs.	PLATE.—Round, flat colonies, edges filamentous. The original colony appears as a white point in center. Edges transparent. Colonies moist and shining. STREAK.—Moist, transparent growth. Condensation water clouded; no film.	PLATE.—Small, irregular shaped, slightly elevated colonies of a whitish grey color. Edges filamentous. Some of the colonies raised and glistening. STREAK. — White elevated, glistening growth.	PLATE.—Large, irregular shaped transparent colonies, which quickly sink into liquefied depressions. Film formed on surface. STAB.—Medium slowly liquefied with film formed, covering entire surface of medium. Edges irregular. Condensation water clear and wrinkled.	Brown, dry, fringe-like growth, covering entire surface of potato.

SPECIES	PLAIN AGAR	SUCROSE AGAR	GELATIN	POTATO
Bac. mes. fuscus (A). Short, thick rods with rounded ends, slightly smaller than previously described types (otherwise similar).	PLATE.—Small, round, flat colonies, similar to type previously described. The growth sometimes appears spreading over entire surface of medium and entirely non-characteristic. STREAK.—Grey, moist, glistening filiform growth. Water of condensation clear; strong film. STAB. — Smooth, grey growth, covering entire surface of plate. Line of puncture filiform.	PLATE.—Round, slightly elevated, colonies transparent and of a gummy consistency. STREAK. — Raised, entirely transparent and narrow. Growth confined to needle track. Condensation water very cloudy; no film.	PLATE.—Large, round, slightly elevated, transparent colonies, which, after a short time, sink into granulary depressions caused by liqufaction of underlying medium. No film formed on liquefied areas. STAB.—Gelatin liquefied slowly; heavy film formed on surface, which gradually sinks into liequefied area.	Surface covered with flat, fatty growth, slightly brown in color, and granulary in parts.
Bac. mes. fuscus (B). Large, sturdy rods, with rounded ends, occurring singly and in chains. Isolated from Sugar No. 85.	PLATE. — Small, round colonies, moist, shining, slightly elevated. STREAK.—Very narrow white streak, confined to immediate vicinity of needle track. Water of condensation clouded; very heavy, wrinkled film. STAB.— Moist, shining, wrinkled, spreading growth. Line of puncture filiform.	PLATE.—Large, glistening, elevated growth. Surface greyish white. In shape somewhat resembling *Bac. vulgatus*. STREAK.—Narrow, transparent, very elevated. Growth confined to needle track and moist glistening edges irregular. Condensation water clear; no film.	PLATE. — Very small white punctiform colonies. Medium liquefied slowly. Liqefied area very cloudy; no film. STAB.— Medium slowly liquefied, surface becoming crateriform. Very heavy wrinkled film.	Growth resembling *vulgatus* type. Vigorous growth of brown mesentery like coils.
Bac. mes. niger. Short, thick bacilli, with rounded ends. Stain by Gram's method. Occuring in pairs. Isolated rom Sugar No. 74.	PLATE.—Small, round, slightly elevated colonies. At first colonies are of light brown color, later they become black. This chromogenesis is quite variable. The colonies are granular in center; edges uniform.	PLATE.— Small, round, white colonies, with transparent center. Edges irregular and filamentous. STREAK.—Flat, spreading, moist, glistening growth, covering entire surface of medium, which is covered with drops of condensation water. Water clouded; no film.	PLATE. — Very small brownish colonies, which quickly sink beneath the surface of the liquefying medium. STAB.—Medium quickly liquefied. Granular film formed, which becomes distributed throughout medium.	Dark brown raised growth, which appears like network, covering entire potato. The color of growth is sometimes black, though this is very variable. The black color is most often observed in old cultures.

Bac. mes. fuscus granulatus. Large, thick rods, with rounded ends. Stain by Gram's method. Occurring singly and in pairs.	PLATE.—Small, round, slightly elevated, granular colonies. Very granular in center. Except for color and granular structure, colonies are typical of the *mes. fuscus* group. STREAK. — Spreading, moist and shining, yellowish growth. Water of condensation clear, with film formation.	PLATE.—Small, round, elevated colonies. The colonies are transparent and very glistening and otherwise characteristic of the *fuscus* group. STREAK.—Flat, spreading, glistening white growth, covering entire surface of medium. Edges smooth. Condensation water clear; no film.	PLATE. — Very small, white punctiform colonies. Liquefaction of underlying medium very slow. STAB. — Granular grey growth on surface. Liquefaction very slow, usually not until after five days. Line of puncture filiform.	Brown, slightly elevated growth, tending to be confined to needle track. Surface granular and the network-like growth is typical of the *mes. fuscus* group.
Bac. liodermos. Long, thin rods, with slightly rounded ends. Very similar in morphological characteristics to *Bac. vulgatus* group.	PLATE. — Small, flat, brown, dry, slightly granular colonies. Colonies amœboid in shape, edges irregular. Except for color, colonies resemble *Bac. mes. fuscus* group. STREAK. — Growth of same color as colonies, Slightly raised and spreading. Condensation water clear, with film.	PLATE.—Very irregular shaped, slightly elevated colonies, spread across the entire surface of plate as radiating arms. In some cases the colonies are yellowish in color as the growth on potato. STREAK.—Moist, glistening, whitish grey growth, spreading over entire surface of medium. Surface granular. Condensation water clear; no film.	PLATE.—Small, round, punctiform colonies. Original colony appearing as a point surrounded by a saucer-like depression. Liquefaction very slow. STAB.—Granular growth on surface. Liquefaction very slow; only observed after five days. Line of puncture filiform.	Very characteristic lemon colored, syrupy growth, which, in general structure, appears identical with the *mes. fuscus* group.

SPECIES	PLAIN AGAR	SUCROSE AGAR	GELATIN	POTATO
Bac. gummosus. Short and very thick rods, with rounded ends. Stain by Gram's method. Cells singly and in chains.	PLATE.—Round, slightly elevated, whitish grey shining colonies. Colonies fatty, glistening appearance as *Bac. megatherium.* STREAK.—Whitish grey, glistening growth, spreading at base, confined to needle track in upper portion of medium. Water of condensation clear, wrinkled film. STAB.—White, glistening growth, covering entire surface. Line of puncture filiform.	PLATE.—Round and irregular shaped colonies, with spreading base, rising to a point in center. Colonies may be either entirely transparent or slightly opaque. In some of the colonies the base is very irregular and assumes various shapes which are very characteristic. The base is sometimes like the leaf of a plant in shape, with beautiful fibrous structure. STREAK.—Raised, spreading, transparent growth covering entire surface of medium. Surface undulating. Water of condensation cloudy; no film.	PLATE.—Large, round, white colonies. Medium is quickly liqefied and after three days medium becomes liquid over entire surface. Heavy film formed, which becomes distributed throughout liquefied area. STAB.—Medium quickly liquefied with heavy film formation.	Growth appears as a narrow grey streak upon the surface of potato. The edges are fringed.
Bac. megatherium. Short and very thick rods, with square ends. Occur singly and in chains. Stain by Gram's method. Spores formed.	PLATE.—Small, round, slightly elevated, moist, shining colonies, fatty lustre of a whitish grey color. STREAK.—Whitish grey, glistening growth, which is wide at base and confined to needle track above. Condensation water clear, with film.	PLATE. — Very large amœboid colonies, slightly elevated, dry transparent surface. STREAK.—White, shining, slightly elevated growth, which is confined to needle track. Water of condensation clear; no film.	PLATE.—Almost identical with the above. Liquefaction very rapid, with film covering entire surface. STAB.—Liquefaction very rapid. Heavy film formed on surface.	Dirty white flat growth, confined to needle track.

these differences in their cultural characteristics, as the biochemical features were quite constant for the various species. The group as a whole are characterized by the high resistance of their spores to heat and their very low nutrient requirements in respect to their nitrogen supply, and in the marked ability to destroy sucrose. All the species developed in albumen free medium as can be noted in the table of biochemical characteristics. The composition of the medium was as follows: Distilled water 1,000 cc., sodium chloride .50 per cent, ammonium lactate .60 per cent, asparagine .40 per cent. This medium is recommended by Vorges (*). The cultural characteristics of the different species vary so greatly at different times that it becomes very confusing and very difficult to determine where the various species end and the new species begin. Many attempts were made to discover such conditions under which we might expect to operate with the result of yielding constant characteristics. To this end various media were used and these tried with various modifications for the puprose of obtaining absolutely uniform results. The ordinary plain agar was used as a medium, and in addition the 10 per cent sucrose agar recommended by Greig Smith was also used. The titration of the medium was usually corrected to plus .50 per cent Fuller's standard. The agar was of 1.5 per cent strength. At times certain variations in the cultural characteristics of the species were found to be due to the variation in the titration of the medium, which was often changed during sterilization. It was found, for instance, that the cultural characteristics of the species in the plain agar titrating plus .50 per cent Fuller's standard was quite different from that on a similar medium of plus 1 per cent. This group of organisms seemed peculiarly influenced by these changes in the titration of the medium in which they grew, which was attributed to the influence of this factor upon their gum-forming property. This view was strengthened by observation that in some old sucrose sugar cultures which we had in 300 cc. Erlenmeyer flasks in the incubator as stock cultures, a liquefaction, or, more probably, a disintegration of the medium was observed. The agar was in the proportion of 1.5 per cent, and although it was not liquefied as the term ordinarily implies, yet it showed a marked disintegration and a tendency to lose its original consistency. This phenomenon was usually observed in sucrose agar where the titration was slightly less than plus .50 per cent Fuller's standard, and as this action upon agar seemed to have been stimulated by the presence of sucrose in the medium, and as it seemed to be also favored by neutral or slightly alkaline conditions, it was supposed that the gum-forming action of the organism had in some way influenced this solidifying property of the agar agar. The phenomenon of the liquefying action of the agar has seldom been observed and there is little available literature upon the subject. Dr. Haven Metcalf, (*) of the University of California, in his work on *Bacterium teutlium,* which he isolated from sugar beets, describes a similar action upon agar on the part of that organism.

---

*Text Book of Bacteriology. Lehmann and Newman.

Dr. Erwin F. Smith, of the Bureau of Plant Industry, United States Department of Agriculture, has also made mention of this phenomenon. When we first observed this liquefaction of agar we attributed it to the possible excessive secretion of diastase which might have had a similar action upon the carbohydrate agar agar as upon starch. This idea was contradicted, however, by the observation that the liquefaction was always more active in sucrose agar than in ordinary plain agar. This was taken as an indication that the action upon agar was not due to diastase, for otherwise we would have expected the secretion of such an enzyme to have been stimulated in the medium where there was no sugar present. To prove the point further, the following experiments were conducted: A solution of the same composition as our standard sucrose solution was made containing 5 per cent of starch instead of sugar. This was solidified with agar and inoculated with a culture of the organism. If the liquefaction of the agar was due to diatase we would have expected to have found a greater liquefaction of agar in the presence of starch, since in this case the lack of a fermentable sugar would have tended to evoke a greater secretion of diastase. The result, however, showed no such action to have taken place in the starch agar, although it had been previously found in our experiments with starch solutions that the organism secreted diastase. It is most likely, therefore, that the disintegration of agar is not due to the action of diastase, but that it is caused in the process of the gum fermentation of sucrose. In old cultures where the sucrose has all been converted into gum, it is very likely that the carbohydrate agar agar is acted upon to a slight extent by the gum-forming enzyme secreted by the organism.

---

*Cent. Bakt.

THE RESISTANCE OF THE SPORES OF THE BACTERIA TO HEAT.

As the initial contamination of sucrose by the deteriorative type of bacteria depends upon the resistance of the spores of these bacteria to high temperatures, it will be of interest to us to investigate this property under laboratory conditions. If we should find in such an investigation that the spores of these organisms can withstand higher temperatures than is reached in the manufacturing process of sugar, we would not expect the contamination of a sugar to depend upon exposures subsequent to the manufacture of such products. For the purpose of testing the resistance of the spores to high temperatures, tubes containing 25 cc. of the standard sucrose solution were prepared and inoculated with cultures in which the spores of the species had been observed. The tubes were then subjected to various temperatures for the various periods indicated in the foregoing table. From this table it will be seen that the spores of the organisms were highly resistant and would easily withstand the temperature incident to the manufacture of sugar. It will be noted from the table that the organisms survived the temperature of 212°, which is ordinarily about the highest temperature reached in sugar manufacture, and that only a few of the spores were entirely destroyed, even after two hours exposure. Even at 230° all of the spores were not killed in fifteen minutes exposure. These results fully explain the fact that the deteriorative type of bacteria are always present in freshly made sugars, as will be seen from Part IV of this publication.

RESISTANCE OF SPORES TO HEAT.

+ Indicates spores killed.
— Indicates spores capable of germination.

Species	Temperature 212° F.				Temperature 230° F.			
	15″	30″	60″	120″	05″	15″	30″	60″
Bac. vulgatus.......	—	—	+	+	—	+	+	+
Bac. vulgatus (B)...	—	—	—	+	—	—	+	+
Bac. vulgatus (C)...	—	—	—	+	—	+	+	+
Bac. vulgatus (D)..	—	—	—	—	—	—	+	+
Bac. mes. ruber.....	—	—	—	—	—	—	+	+
Bac. mes. fuscus.....	—	—	—	+	—	+	+	+
Bac. mes. fuscus (A)	—	—	+	+	—	+	+	+
Bac. mes. fuscus (B)	—	—	+	+	—	—	+	+
Bac. mes. niger.....	—	—	—	+	—	—	+	+
Bac. liodermos......	—	—	—	+	—	—	+	+
Bac. mes. granulatus	—	—	—	+	—	—	—	+
Bac. gummosus......	—	—	—	+	—	+	+	+
Bac. megatherium (A)	—	—	—	+	—	—	+	+
Bac. sacchari........	—	—	+	+	—	+	+	+
Bac. megatherium (B)	—	—	+	+	+	+	+	+

RESISTANCE TO FORMALDEHYDE.

The use of formaldehdye as an antiseptic for the preservation of sugar products is almost universally practiced in the sugar, industry, where it becomes necessary to use such an agent. This antiseptic is more often used upon the occasion of a breakdown in mills where juice or syrup would be likely to deteriorate through fermentative action. In such cases it is customary to add small quantities of this antiseptic so that fermentation would be held in check while waiting for the work to be resumed. As the proportion in which this material is used varies in different localities, it was thought that it might be interesting to determine the proportion in which it would be effective as an antiseptic towards the organism causing the gum fermentation of sugars. From the above table it will be seen that in the proportions of 1 to 5,000 of 40 per cent formaldehyde all the species were completely restrained. Spencer (*) recommends 6 cc. of 40 per cent formaldehyde per cubic foot of raw juice, which is approximately equivalent to 1 to 5,000. In the proportion of 1 to 10,000 formaldehyde was efficient as an antiseptic

---

*Spencer's Handbook for Cane Sugar Manufacturers.

RESISTANCE TO FORMALDEHYDE.

Species	1:10,000		1:5000		1:2500		1:1000		1:100	
	Antiseptic	Germicidal	Antiseptic	Germicidal	Antiseptic	Germicidal	Antiseptic	Germicidal	Antiseptic	Germicidal
Bac. vulgatus (A)	—	—	+	—	+	—	+	—	+	+
Bac. vulgatus (B)	+	—	+	—	+	—	+	—	+	+
Bac. vulgatus (C)	+	—	+	—	+	—	+	—	+	+
Bac. vulgatus (D)	+	—	+	—	+	—	+	—	+	+
Bac. mes. fuscus (A)	+	—	+	—	+	—	+	—	+	+
Bac. mes. fuscus (B)	—	—	+	—	+	—	+	—	+	—
Bac. mes. fuscus (C)	+	—	+	—	+	—	+	—	+	—
Bac. mes. niger	+	—	+	—	+	—	+	—	+	+
Bac. liodermos	—	—	+	—	+	—	+	—	+	—
Bac. mes. granulated	+	—	+	—	+	—	+	—	+	—
Bac. gummosus	—	—	+	—	+	—	+	—	+	+
Bac. megatherium (A)	—	—	+	—	+	—	+	—	+	+
Bac. sacchari	—	—	+	—	+	—	+	—	+	+
Bac. megatherium (B)	—	—	+	—	+	—	+	—	+	+
Bac. mes. ruber	+	—	+	—	+	—	+	—	+	+

in about fifty per cent of the cases, as shown in the above table. It is likely that it would in proportions of 1 to 7,500 be sufficient to restrain the development of these organisms. It will be further noted that even in the concentration of 1 to 100 formaldehyde was not germicidal upon all of the species investigated. As it is very rarely used as a germicide the proportions in which it possesses this property is of less interest than that of its antiseptic properties. From the foregoing table of results, therefore, it appears that formaldehyde to be absolutely efficient as an antiseptic for the gum-forming organisms should be used in the proportions of 1 to 5,000.

DEVELOPMENT OF ORGANISMS AT ELEVATED TEMPERATURES.

In the investigation of the properties of the species constituting the bacterial flora of sugars, it was found that the optimum temperature for their development was 37.5° C., but it was found that they could adapt themselves to a very wide range of temperature conditions. As their natural environment would represent many variations in temperatures, it is natural to suppose that the group as a whole would not be very rigid in their requirements in respect to temperature. As certain cases of deterioration of sugar products during the course of manufacture suggested the power of the gum-forming organisms to cause an active deterioration of sugar products at very elevated temperatures, it was thought that an investigation of this property would prove of interest. The various temperatures were tried from 37.5° C. to 65° C. (100-150° F.) with results as indicated in the foregoing table. It will be noted that no development could be observed at temperatures higher than 130° F., and even at this temperature a large per cent of the cases showed no development.

GROWTH AT ELEVATED TEMPERATURES.

+ Indicates Growth.
— Indicates No Growth.

SPECIES	99.5° F. 37° C.	130° F. 55.25° C.	140° F. 60° C.	150° F. 65° C.
Bac. vulgatus (A)	+	+	—	—
Bac. vulgatus (B)	+	—	—	—
Bac. vulgatus (C)	+	—	—	—
Bac. vulgatus (D)	+	—	—	—
Bac. mes. fuscus (A)	+	—	—	—
Bac. mes. fuscus (B)	+	—	—	—
Bac. mes. fuscus (C)	+	—	—	—
Bac. mes. niger	+	—	—	—
Bac. liodermos	+	+	—	—
Bac. mes. granulatus	+	+	—	—
Bac. gummosus	+	—	—	—
Bac. megatherium (A)	+	+	—	—
Bac. sacchari	+	—	—	—
Bac. megatherium (B)	+	—	—	—
Bac. mes. ruber	+	+	—	—

In concluding this part of our investigation we will state that the bacterial flora of sugars comprises the well-known potato group of bacilli. These speices cause an active destruction of sucrose owing to their ability to transform it into gum levan. It is very likely that the gum-forming organisms described by other authors were in reality members of this group, which, owing to change of environment, show some cultural variations. The principal characteristics of this group of organisms are:

1. Their ability to form gum from sugars.
2. The high resistance of their spores to heat.
3. Their very low nutrient requirements.

And it will be noted that all of these characteristics correspond to those of the potato group of organisms.

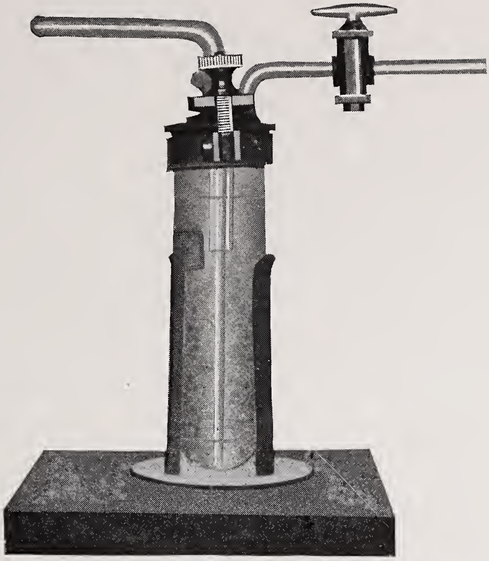
The Bacterial Deterioration of Sugars.

PART II.

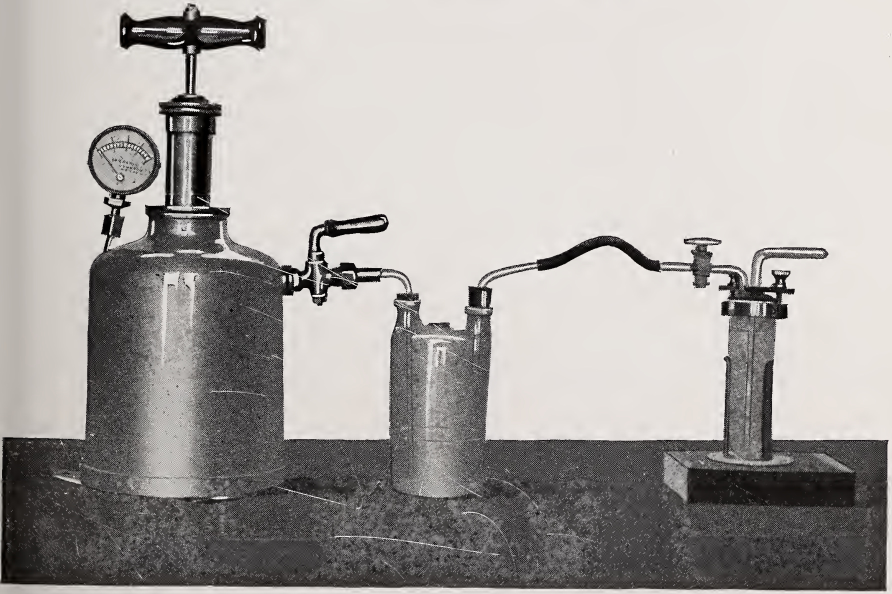
RESULTS OF EXPERIMENTS UPON THE DETERIORATION OF SUGARS.

Having isolated the species of bacteria that were found to occur most extensively in sugars and which were suspected of being the causative agents in the deterioration that the products from which they were isolated were undergoing, it was the next step in the investigation to determine the relative powers of deterioration of the various species. It was also of great importance to ascertain the relative activities of each species on different classes of sugars in order that the factors influencing this action might be discovered. The control work on the sugar samples had shown the range of bacterial association to be quite extensive since almost all of the samples on hand were falling in polarization from month to month and since the characteristic organisms were found in nearly all of them. As the samples had been collected from all parts of the world, it indicated that this type of organism is not confined to any particular locality, but is prevalent wherever sugar is manufactured to any extent. It is obvious therefore that the problem of deterioration of sugars by bacteria is almost world-wide and by no means a local condition. The monthly analyses which were made on the samples together with the careful records of the bacterial flora of the products furnished excellent data upon the relation between the deterioration of a sugar and the micro-organisms occurring therein. Such records were of interest furthermore because the variety of samples at our disposal were representative of all the various grades of sugars and methods of manufacture, and thus afforded ample opportunity for correlative studies of the influence of these factors upon the keeping qualities of a sugar. But it was necessary to supplement these studies of sugars under natural conditions of bacterial contamination with others designed to show what pure cultures of the various species would bring about when introduced into sterilized sugars. It was only in this way that the deteriorative action of each species could be definitely ascertained since the deterioration of a sugar in which many species occurred would naturally be attributed to their collective activities. It would be impossible under such conditions to determine the relative parts played by the various species in bringing about the deterioration of a sugar. If there existed a certain interdependence between the species in their activities the use of pure cultures in inoculating sterile sugar would readily demonstrate it. The necessity of sterilizing the sugars used in these experiments confronted us with a somewhat difficult operation, as this material is quite readily changed by the temperature necessary for a complete sterilization, as, owing to its physical condition, it has to be heated for a considerable length of time in order for the heat to penetrate through the mass. In addition to these conditions, which render the sterilization of sugar a difficult procedure, the extraordinary viability of the spores of the organisms constituting the bacterial flora of sugars makes it next to impossible to practice the single sterilization method without subjecting the material to temperatures that would cause both physical and chemical changes therein. It was necessary therefore to adopt the intermittent sterilization method, which was used with a fair degree of success throughout our experiments. The sugars were first placed in liter Erlenmeyer flasks, usually about 500 grams to the flask, and after plugging with cotton they were placed in the autoclave and subjected to a temperature of 220° F. for thirty minutes on each of three consecutive days. At the end of this period the success of the sterilization was determined by inoculating culture tubes of nutrient sucrose solution with small quantities of sugar from the flasks of sterilized sugars. Where any development took place in the inoculated tubes the flask of sugar from which the tube was inoculated was discarded and only those were used in the experiments that gave no growth when transferred to culture media. The sterile sugar was next inoculated and placed in the incubator at a temperature of 37.5° C., where it was kept for a period of thirty days usually before being analyzed. In every case uninoculated control flasks were kept under conditions identical with those of the inoculated as a check on the results. The inoculation of sugars gave some trouble, as it was very difficult to distribute the inoculating material uniformly throughout the sugar by the ordinary method of using agar cultures. A uniform distribution of the inoculating material is particularly to be desired in this case, as the sugar crystals do not offer a continuous surface for the development of bacteria and the extension of the inoculated portion so that the spread of the organisms throughout the mass is somewhat slow. On the other hand, there is the objection to the use of liquid cultures for inoculating purposes on account of increasing the moisture content of a sugar. As this factor is often a limiting one in the deterioration of sugars, it is obviously a great disadvantage to change the moisture content in our experiments since the results from such inoculations might not be applicable to the particular sugar with its original moisture content. In order to obviate the necessity of using culture solutions in our inoculations several methods were tried with only partial success. One of these was the use of ordinary river sand, which was first treated with hydrochloric acid to remove all of the bases so that the degree of acidity produced in the sugars would not be changed. After the sand had been thus freed of its bases and then washed thoroughly the culture to be used was transferred from the culture flask and mixed thoroughly with it. The sand mixture was then transferred to the flask containing the sterile sugar, where it was thoroughly mixed by shaking. The chief objection to this method was that the sand would often introduce an error in the analytical work, and even where this did not occur there still remained the objection that the addition of the sand would affect the physical condition of the sugar. It is not very probable that the presence of the small amount of sand used in the inoculations would affect the bacterial action in a sugar. At the same time it is conceivable that where a grain of sand interrupts the sugar crystals or their surrounding films that it might act as a barrier, or, at least, impede the progress of the organisms between the crystals and in this way retard the distribution of the inoculation throughout the mass of sugar.

Another method of inoculation that suggested itself was the use of dried agar cultures, but to this there was the same objection as to the sand, since the material thus introduced within a sugar would constitute a likely source of error in analysis and might also affect the progress of the organisms between the crystals. In addition to these, however, are the further objections of the possibility of inducing a certain degree of attenuation in the cultures by drying, and the disadvantage of adding traces of nutrient material contained in the dried culture. This method was used to a limited extent, and although it was found that the drying of the cultures did not seem to affect the virility of the micro-organisms, yet the method was discarded because of the possibility of altering the natural nutrient value of the sugar as a culture medium by the addition of the dried culture. Although only traces of nutrient elements might be added to the sugar by this method, yet it might affect the action of the bacteria, particularly because of the small amount of such elements that it naturally contains. One of the methods that was used somewhat extensively in the inoculation of sugars and which proved fairly satisfactory and without the disadvantages of the methods so far described was that of first inoculating small quantities of sterile sugar and after the organisms had developed therein this was transferred to large quantities of the same sugar. The sugar was sterilized in the usual way in 500 cc. flasks and also in smaller quantities in test tubes. After sterilization the tubes were inoculated by means of a platinum loop upon which small portions of agar culture were transferred from the stock culture. The inoculated tubes were then incubated at 37.5° C. for several days at the end of which time the success of the inoculation was first determined by transferring small portions of the sugar to culture media before the contents of the tubes were transferred to the larger flasks. Where the transfers from the tubes to the culture medium showed that the inoculations had been effective the flasks were inoculated by pouring out the contents of the tubes and mixing them with that of the larger flasks. In some cases bacterial counts were made of the tubes before using, but in most cases the development from the sugar transferred from the tubes to the culture medium was made the criterion for the transfer to the large flasks. The principal objection to this method was that in many cases the sugar would become so tightly packed in the tubes during sterilization that it would be almost impossible to remove it. This was particularly true of the lower grade sugars, which exhibit a marked tendency to cake when heated.



FLASK FOR THE ATOMIZATION OF INOCULATING SOLUTIONS.



SUGAR INOCULATING APPARATUS.

(A) Air pump and chamber.
(B) Flask containing sulphuric acid for the sterilization of air supply.
(C) Atomizer.

The use of culture solutions has much to recommend it as a means of inoculating sugars. It is much easier to secure a uniform inoculation in this way than by the dry method, and it is also free from the objection that applies to the addition of any foreign substance to the sugar as in the case of such methods. By using the same quantity of solution in the uninoculated control flask as is used in the inoculations, the moisture content of the flasks is equalized and no corrections are rendered necessary in the analysis. As most of the anaylses in these experiments were made with corrections for moisture, the addition of moisture in inoculation offered no difficulty in the analytical work. The objection still remains, however, that the addition of moisture renders a sugar more susceptible towards the particular action that we wish to induce and to that extent has the disadvantage of changing the natural relation between the sugar and its tendency towards deterioration. If solutions are used in inoculations it is necessary therefore to use as small quantities as possible so that the moisture content of the sugar may not be materially increased. In order to distribute the minimum quantity of the solution through a maximum amount of sugar advantage was taken of the principle of atomization and a device was designed having this as a basis. The apparatus consisted of three parts, viz: (1) an air pump and air cylinder combined in which an air pressure of several Kg. could be maintained, (2) an ordinary double neck bottle in which sulphuric acid is kept for the sterilization of the air supply, and (3) an atomizer for the atomization of the culture solution. The atomizing flasks were detachable from the other parts of the apparatus so that cultures to be used might be generated in these flasks, which could be attached just as they were needed. The method used was as follows: a nutrient medium consisting of distilled water to which .01% peptone was added was used for the propagation of the culture. About 10 cc. of this medium was placed in each of the atomizing flasks and sterilized in an Arnold sterilizer. After sterilization the flasks were inoculated with the cultures to be used by transferring with the platinum wire small portions of the agar culture to the flasks. In order to thoroughly mix the inoculating material with the liquid in the flasks the platinum wire containing the agar culture was introduced into the inlet tube as far as possible and the liquid then brought in contact with it by tilting the flask. After inoculation, the flasks were placed in an incubator and kept at 37.5° C. for several days until the cultures had reached a high state of development, as indicated by the cloudiness of the liquid in the flasks, when they were then removed and used in inoculating sugars. The flasks were fitted with very closely fitting ground glass tops, which, when greased, would prevent any contamination of the inoculating medium. As the inlet and outlet tubes were always plugged with cotton during the sterilization and incubation periods, there was little danger of contamination from that source. In every series of flasks used in these inoculating experiments there was one left uninoculated as a control, which served to test the efficacy of the method. There were very few cases in which the control flask showed any contamination, and, in fact, the percentage of such cases was not greater than would occur in ordinary routine work where very resistant organisms are used and sterilization methods more apt to be ineffective. But it is barely possible, of course, that there might have been a certain amount of contamination within the control flask without it being noticeable owing to the small amount of nutrient elements contained in the inoculating medium. Conditions offered by this medium would not likely promote a very rapid or vigorous growth of the majority of bacterial species, so that it is perfectly conceivable that a few bacteria having gained access to the control flask would likely develop so slowly that their presence therein might never be suspected. In exactly the same way we might introduce in our inoculation of sugars a few cells of a different species of bacteria from that of our culture without affecting in the least the ultimate purity of the culture that we used. It is only because sugars do not offer conditions favorable for the development of micro-organisms in general that the inoculating apparatus used in these experiments is permissable on a strictly scientific basis. As the flasks have to be connected to the other part of the apparatus by rubber tubing, which is not at all readily sterilized, and as the passage of the air through sulphuric acid may not always be relied upon to sterilize the air, in most cases it can not be considered as reliable as sterilization by heat.

CULTURE No.	Date of Inoculation	Date of Analysis	Clerget (Moisture Free)	Single Polarization (Moisture Free)	Reducing Sugars	Date of Second Analysis	Clerget (Moisture Free)	Single Polarization (Moisture Free)	Reducing Sugars	Moisture
Control........	Aug. 21	Sept. 21	90.16	87.8	4.17	Oct. 21	91.53	87.4	4.88	2.22
Bac. vulgatus (A).............	Aug. 21	Sept. 21	89.74	85.8	4.44	Oct. 21	88.31	84.7	5.88	3.52
Bac. vulgatus (B).............	Aug. 21	Sept. 21	90.68	88.0	3.92	Oct. 21	92.36	87.9	4.54	2.03
Bac. vulgatus (C).............	Aug. 21	Sept. 21	89.79	87.0	4.59	Oct. 21	90.52	86.0	5.55	2.24
Bac. mes. fuscus (A)...........	Aug. 21	Sept. 21	90.73	88.0	4.03	Oct. 21	91.80	87.7	5.00	2.07
Bac. mes. fuscus (B)...........	Aug. 21	Sept. 21	90.00	87.6	4.22	Oct. 21	91.50	87.0	5.13	2.30
Bac. mes. fuscus (C)...........	Aug. 21	Sept. 21	90.16	87.8	4.03	Oct. 21	92.23	88.0	4.65	2.09
Bac. liodermos.................	Aug. 21	Sept. 21	90.44	86.4	4.44	Oct. 21	89.84	84.6	5.71	3.05
Bac. mes. granulatus...........	Aug. 21	Sept. 21	90.74	87.6	4.03	Oct. 21	91.11	87.4	5.00	1.77
Bac. megatherium..............	Aug. 21	Sept. 21	90.69	88.4	3.92	Oct. 21	92.55	88.5	4.65	1.89

The apparatus is not therefore one that could be considered of absolute accuracy in so far as the atomization of a pure culture is the purpose of its use, but under the conditions of the experiment and the nature of the material upon which it was intended to be used it was to be regarded as a thoroughly reliable method.

THE RESULTS OF EXPERIMENTS ON THE DETERIORATION OF SUGAR.

The sugar that was used in our inoculation experiments was the large crystal type manufactured in Peru. On account of the size of the crystals it was much easier to sterilize it without caking it during the heating process than would have been the case with a smaller crystal sugar. After inoculation the sugar was placed in an incubator, where it was kept at a temperature of 37.5° C. for a month, when it was again analyzed. The results of the foregoing tables show the changes that were produced in the sugars by the species of micro-organisms with which they were inoculated. It will be noted that in almost every case the single polarization indicated a decrease in sucrose and the Clerget shows a corresponding increase. As the reducing sugar had almost invariably increased, it indicated that some deterioration must have taken place, and that the Clerget determination had most likely been subjected to an error. In our first experiment upon sugars we discarded all results that showed this peculiarity, as we attributed such an increase of sucrose Clerget to the lack of uniform sampling or some error in manipulation. Results of this kind, however, were obtained so consistently in our subsequent work that we were compelled to regard the phenomenon as a constant factor in the bacterial deterioration of sugars. It required some time for us to discover just what caused this phenomenon, and it is to Assistant Chemist W. G. Taggart, who was in charge of the analytical work in these investigations, that the credit for the explanation of this is due. Mr. Taggart attributed this increase in sucrose Clerget in the analysis of the sugar to the presence of levan. He reasoned that this levorotary gum, which tends to decrease the single polarization by its optical activity would have a tendency to increase the Clerget determination through its hydrolysis into levulose during the inversion. In order to test the point still further, however, he compared the analyses of these sugars by the ordinary Clerget method with the analyses made where invertase was used for the inversion of the sugars. It was found that invertase did not act upon the levan. He reasoned that this method would eliminate any error that was due to the hydrolysis of levan into levulose by the use of acid.

The effect of gum on sucrose Clerget, as shown from comparison of sucrose Clerget with true sucrose determined by Hudson's invertase method:

		Single Polarization	Sucrose Clerget	True Sucrose Invertase Method
Sample No. I.	Refined Sugar	99.98	99.99	99.98
Sample No. II.	Inoculated solution containing gum	0.00	0.8	0.17
Sample No. III.	Peruvian Crystals	91.20	95.0	91.4
Sample No. IV.	From Gramercy	87.0	89.82	87.6

The results of these experiments as given in the foregoing table conclusively show that the high Clerget results were to be attributed to the presence of levan in the sugars. The difference in result by the two methods was convincing of the presence of levan in the sugars and it showed that this diffiulty was quite readily overcome by the substitution of invertase for the acid method of inversion. The invertase used in this experiment was prepared from yeast by the following method, as recommended by Dr. C. S. Hudson: (*) Four or five pounds of baker's compressed yeast was obtained and broken up into a finely divided mass in a mortar. This was placed in a flask and chloroform added and allowed to act for 48 hours, at the end of which time the mass had become almost completely liquefied. This liquid was then precipitated with lead subacetate and the excess of lead removed with potassium oxalate, and the filtrate was then placed in a pig's bladder and dialyzed for 24 hours to remove all of the impurities. A few drops of toluene were added to prevent fermentation or any decomposition changes of the invertase. Further proof of the presence of levan in those sugars whose analysis indicated that it had been formed therein is lacking owing to inability to separate this material from such products. In many cases we were able to obtain by alcoholic precipitation certain bodies that resembled the gum in their optical activity, but all efforts to purify it to a point where its identification could be proved were fruitless. In those sugars where the Clerget always indicated the presence of levan there were so many impurities precipitated by alcohol that the levan could not be identified. It was found, however, that even where levan was added to this class of sugar it could not be recovered from them in such a state of purity as would permit of its identification. Where it was added to higher grades of sugar it could be separated, but in every case where it was tried upon the sugar suspected of containing levan the effort always met with failure. This experiment conclusively proves that negative results in the isolation of levan from sugars cannot be taken as an indication of its absence in such products. In the light of these results, and in view of the preponderance of evidence indicating the formation of levan in sugars by the organisms causing their deterioration, it seems certain that the presence of this substance is responsible for the error in the Clerget method of determining sucrose. As the organisms constituting the bacterial flora of sugars have been found to develop gum in all cases where they attack sucrose, and as these species have been found in all of the sugars undergoing deterioration, it seems certain that the formation of levan was responsible for the phenomenon. The correction of this error by the use of invertase, which has no action upon levan, is further proof of the presence of this gum in those sugars where the Clerget was so much higher than the single polarization. Mr. Taggart (*) has calculated the influence of levan upon both the single polarization and the Clerget method of analysis, and has found that one per cent of levan will decrease the single polarization .60V and increase the Clerget .67V.

---

*C. S. Hudson, Bulletin Bureau of Chemistry, U. S. Dept. Agriculture.

---

*Mr. Taggart has now in the course of preparation a paper on the influence of levan upon the analyses of sugars.

ANALYSES OF SUGAR SAMPLES, SHOWING DETERIORATION IN STORAGE.

Sample No.	Date of Analysis	Clerget (Moisture Free Basis)	Single polarization (Moisture Free Basis)	Reducing Sugars	Moisture
Sugar No. 31—					
31.............	August, 1909......	....	96.72	2.47	.80
31.............	September, 1909...	96.71	96.42	2.26	.95
31.............	February, 1910....	90.19	86.2	2.22	1.05

Sample No.	Date of Analysis	Clerget (Moisture Free Basis)	Single polarization (Moisture Free Basis)	Reducing Sugars	Moisture
Sugar No. 32—					
32.............	August......	....	95.9	3.27	.90
32.............	September	95.79	95.49	3.83	1.35
32.............	February	89.74	85.15	3.22	1.36

Sample No.	Date of Analysis	Clerget (Moisture Free Basis)	Single polarization (Moisture Free Basis)	Reducing Sugars	Moisture
Sugar No. 33—					
33.............	August	....	79.48	10.0	6.20
33.............	September	82.15	78.42	10.2	6.40

Sample No.	Date of Analysis	Clerget (Moisture Free Basis)	Single polarization (Moisture Free Basis)	Reducing Sugars	Moisture
Sugar No. 34—					
34.............	August, 1909......	....	83.66	11.76	4.50
34.............	September, 1909....	84.14	81.32	9.52	6.05

ANALYSES OF SUGAR SAMPLES, SHOWING DETERIORATION IN STORAGE—Continued.

Sample No.	Date of Analysis	Clerget (Moisture Free Basis)	Single polarization (Moisture Free Basis)	Reducing Sugars	Moisture
Sugar No. 39—					
39	August, 1909	....	90.45	....	5.25
39	September, 1909	89.84	90.14	....	5.70
39	February, 1910	93.99	89.34	1.72	5.53

Sample No.	Date of Analysis	Clerget (Moisture Free Basis)	Single polarization (Moisture Free Basis)	Reducing Sugars	Moisture
Sugar No. 40—					
40	August	....	92.35	....	3.30
40	September	90.99	91.52	....	3.85
40	February	92.65	91.88	2.08	4.01

Sample No.	Date of Analysis	Clerget (Moisture Free Basis)	Single polarization (Moisture Free Basis)	Reducing Sugars	Moisture
Sugar No. 41—					
41	August	....	97.68	....	.90
41	September	97.56	97.37	....	1.00

Sample No.	Date of Analysis	Clerget (Moisture Free Basis)	Single polarization (Moisture Free Basis)	Reducing Sugars	Moisture
Sugar No. 43—					
43	August, 1909	....	92.75	....	3.50
43	September, 1909	91.86	90.51	....	6.20

ANALYSES OF SUGAR SAMPLES, SHOWING DETERIORATION IN STORAGE—Continued.

Sample No.	Date of Analysis	Clerget (Moisture Free Basis)	Single polarization (Moisture Free Basis)	Reducing Sugars	Moisture
Sugar No. 46—					
46	August, 1909	....	98.08	....	.90
46	September, 1909	97.76	98.02	....	1.15

Sample No.	Date of Analysis	Clerget (Moisture Free Basis)	Single polarization (Moisture Free Basis)	Reducing Sugars	Moisture
Sugar No. 47—					
47	August, 1909	....	97.94	....	.65
47	September, 1909	98.22	98.03	....	.85

Sample No.	Date of Analysis	Clerget (Moisture Free Basis)	Single polarization (Moisture Free Basis)	Reducing Sugars	Moisture
Sugar No. 50—					
50	August, 1909	....	85.59	....	4.20
50	September, 1909	86.72	85.64	....	4.25
50	February, 1910	85.59	84.84	7.14	4.41

On the opposite table will be seen the results of deterioration of sugars under natural conditions. These results are from the analyses made of the sugar samples that were kept in the laboratory. It will be noted that the results from this work were similar to those under conditions of pure culture inoculation, which tends to confirm the theory of the formation of levan. It will be noted that in almost every case the single polarization showed a decrease in sucrose and the Clerget a corresponding increase. Owing to the many irregularities in the analyses of sugars occasioned by the presence of levan formed in the deterioration, this work was discontinued and experiments with sugar solutions taken up. It was thought that in this way conclusions in the matter would be more readily reached.

PART III.

THE NATURE OF THE BACTERIAL DETERIORATION OF SUGARS AND THE CONDITIONS AFFECTING THIS ACTION.

The results of experiments upon the deterioration of sugars as induced by pure culture inoculations and as observed under natural conditions would indicate that the action of the bacteria upon sugars is not that of a normal inversion.

Grieg Smith, (*) who first discovered the gum formed by the organism occurring in sugar and gave it the name of levan, accredits the organism with the power of inverting sucrose. His theory is that the organisms first invert the sucrose and from the nascent levulose and dextrose thus formed levan is produced. His ground for the nascent levulose and dextrose origin of the gum is that he was unable to produce it from either of these sugars in their natural condition. He therefore holds to the opinion that the formation of gum is dependent upon certain properties peculiar to these sugars in their nascent stage. It is very evident, as we have already observed in our experiments upon sugars, that the formation of gum is intimately associated with the deterioration brought about by bacteria. We would scarcely suspect the conditions of the sugar to be favorable for the action of invertase which according to O'Sullivan and Thompson (†) is inactive in any concentration of sucrose greater than 40 per cent.

Moreover, very few bacteria secrete the invertase enzyme. Fermi, (‡) who has made a thorough investigation of this subject, has found that this power is possessed by very few bacteria and these are only able to bring about a very weak inversion of sugars. The formation of levan in sugar was very strongly indicated in our results upon the inoculation of sugars. This action, according to Smith's theory, presupposes the inversion of sucrose as the initial stage of gum formation. According to his theory the formation of gum is more of the nature of a by-product than the principal product of this bacterial action. If this were true, it would seem possible that there would be certain conditions in which sucrose would be destroyed by these micro-organisms without any gum formation. It seems likely, for example, that under certain conditions the inverting action of the organisms might be stimulated, while gum formation might be entirely suspended. If the two actions are distinct it does not seem improbable that the optimum conditions for each might be thus differentiated. As one of the conditions affecting the action of invertase is the concentration of sucrose, we might first investigate its influence upon the action of the bacterial species constituting the bacterial flora of sugars.

---

*Proceedings of the Linnean Society of New South Wales, Vol. XXVI, Series 1, p. 602.

†Transaction Journal of Chemical Society of London, Vol. LVII, 1890, p. 834.

‡Cent. Bakt., Vol. XII, 1892, pp. 713-715.

Experiment No. 1.

INFLUENCE OF CONCENTRATION OF SUCROSE UPON GUM FORMATION.

The plan of this experiment was as follows: a culture medium of the following composition was used:

Peptone	.10 per cent
Sodium phosphate	.20 per cent
Potassium chloride..............	.50 per cent

Sucrose in quantities varying from 1 to 10 per cent as follows:

Series A.	2 Flasks 250 cc each,	10	per cent sucrose
Series B.	2 Flasks 250 cc each,	8	per cent sucrose
Series C.	2 Flasks 250 cc each,	5	per cent sucrose
Series D.	2 Flasks 250 cc each,	2.5	per cent sucrose
Series E.	2 Flasks 250 cc each,	1.0	per cent sucrose

Only one culture was used in these experiments, as it was thought that the results from this culture would be representative of the action of the group of bacteria and the work would in this way be greatly facilitated. As the group of organisms was fairly constant in the respective behavior of the different species under different conditions, it was thought that these results would show the conditions favoring the formation of levan.

EXPERIMENT No. I.—INFLUENCE OF CONCENTRATION OF SUCROSE UPON THE FORMATION OF GUM.

Culture used, Bacillus vulgatus.

SERIES	Acidity—20 cc. used; cc. N/10 K. OH required	Reducing Sugar	Single Polarization	Clerget	Gum
A. Control	0.5	....	38.0	38.43	....
A. Inoculated	1.7	17.24	11.0	17.14	10.41
B. Control	0.4	....	28.6	29.27	....
B. Inoculated	2.8	12.90	9.8	15.05	12.62
C. Control	0.5	....	33.7	35.16	....
C. Inoculated	2.4	18.18	7.8	13.46	11.15
D. Control	0.5	....	23.4	23.98	....
D. Inoculated	2.3	14.82	1.6	6.89	10.02
E. Control	0.4	....	9.5	9.32	....
E. Inoculated	1.6	0.16	7.9	7.94	0.58
F. Control	0.4	....	7.3	7.17	....
F. Inoculated	1.5	0.16	6.0	6.28	0.73
G. Control	0.3	....	5.0	4.88	....
G. Inoculated	1.5	0.12	4.2	4.2	0.35
H. Control	0.2	....	2.5	2.52	....
H. Inoculated	1.7	0.14	0.9	1.08	0.34
I. Control	0.2	....	1.0	.91	....
I. Inoculated	1.5	0.06	0.2	....	0.17

From the foregoing table of results it will be observed that in every case where sucrose has been destroyed levan has been formed. From this it would seem that the formation of levan is a very constant factor in the deterioration of sucrose, although the amount of gum shown by the analysis is not in every case proportionate to the amount of sucrose destroyed. In this connection, however, it must be remembered that the gum is to some extent transitory owing to the fact that it is quite readily hydrolized by the acids formed in the course of fermentation.

We find the ratio between loss of sucrose and the formation of gum to be highest in Series C, where the amount of gum formed is 93 per cent of the sucrose destroyed. It must be borne in mind, however, that the sucrose as determined by both single polarization and Clerget was subject to the error of analysis due to the presence of levan. This substance, as previously noted, tends to make the single polarization lower and the Clerget higher. Our attempt, therefore, to show the relation between the loss in sucrose and the formation of gum would be subject to the error introduced by the presence of that substance. The experiment shows that the greatest per cent of gum formed to sucrose destroyed was coincident with the presence of the largest per cent of reducing usgar to destroyed sucrose. It seems, therefore, that reducing sugars are not the origin of the gum, for otherwise we would find the largest ratio of gum to destroyed sucrose in the case where the ratio of reducing sugars to destroyed sucrose was lowest. In Series C, where we have the highest per cent of destroyed sucrose represented in the gum formed, we also have the largest per cent of reducing sugars, and, although the optical activity of the gum introduces an error in our Clerget from which we are making our comparisons, yet this error does not invalidate our comparative data. It will be seen, further, in our study of the table of results that the concentration of sucrose most favorable for the development of gum seems to be about 20 per cent, while the largest per cent of gum formed to sucrose destroyed takes place at 25 per cent. In none of these various concentrations is there any suggestion of a typical inversion having taken place, and it has been shown that the presence of the largest amount of reducing sugars is associated with the highest ratio between destroyed sucrose and gum development. It appears obvious that the formation of gum does not depend upon a previous inversion of the sucrose. In order to determine the highest concentration at which the gum formation will take place, this experiment was continued and concentrations of sucrose up to 60 per cent were used. The sucrose determinations in these cases were qualitative and it was found that the gum development would take place in concentrations as high as 60 per cent. Ritsert (*) also found that his gum bacillus produced gum in concentrations as high as 60 per cent. In this concentration the formation of gum by the species that we have studied is very weak.

---

*Berichte Deutschen. Pharmazeutischen. Gesellschaft. Vol. I, 1891, pp 389, 390.

EXPERIMENT NO. 2.

THE INFLUENCE OF REDUCING SUGARS ON THE FORMATION OF GUM.

We have seen from Experiment No. 1 that the concentration of the sucrose, while affecting the formation of gum, does not seem to show any evidence of any inverting action associated with this process. It will be interesting, therefore, to see to what extent the formation of gum is influenced by the presence of reducing sugar in the medium. The solution used in this experiment was the same as that used in Experiment No. 1, except for the reducing sugars, which was made the varying factor. The series was as follows:

Series A. 10 per cent sucrose—No reducing sugars
Series B. 8 per cent sucrose— 2 per cent reducing sugars
Series C. 5 per cent sucrose— 5 per cent reducing sugars
Series D. 2.5 per cent sucrose— 7.5 per cent reducing sugars
Series E. 1 per cent sucrose— 9 per cent reducing sugars
Series F. No sucrose —10 per cent reducing sugars

EXPERIMENT No. II.—INFLUENCE OF REDUCING SUGARS UPON THE FORMATION OF GUM.
Culture used, Bacillus vulgatus.

SERIES	Acidity—20 cc. used; cc. N/10 K. OH required	Reducing Sugar	Single Polarization	Clerget	Gum
A. Control	0.1	....	9.3	8.68	....
A. Inoculated	1.5	0.79	8.0	8.28	0.71
B. Control	0.8	1.89	7.1	7.43	....
B. Inoculated	2.0	2.67	6.1	6.76	1.05
C. Control	1.0	4.44	3.8	4.74	....
C. Inoculated	2.5	6.06	1.6	2.64	0.87
D. Control	1.3	6.90	1.1	2.51	....
D. Inoculated	2.8	7.14	0.6	1.97	0.29
E. Control	1.4	8.00	0.6	0.72	....
E. Inoculated	2.8	8.50	0.7	0.73	0.21
F. Control	1.5	8.70	1.6	....	....
F. Inoculated	3.2	8.70	1.7	....	....

From the foregoing table it will be seen that the greatest amount of gum was formed in Series B, where there was 7 per cent sucrose and more than 3 per cent of reducing sugars, and in Series F, containing 8.7 per cent of reducing sugars, no gum was formed. It will be noticed, further, that the gum formation in Series B to Series F , inclusive, is proportionate to the sucrose content. Indeed the presence of reducing sugars seems to have little influence in gum formation and the results of this experiment are only a repetition of the previous one, in which the concentration of the sucrose was the only variable factor. The variation of reducing sugars in the above experiment seems to affect the formation of gum only in so far as it has been accompanied by variations in the per cent of sucrose. If the gum was formed from reducing sugars it would seem that the increase of reducing sugars would have been followed by an increased amount of gum formed. In the above case the reducing sugars used were in the form of equal parts of dextrose and levulose which were added to the solution. In order to determine the affect of varying proportion of these two sugars and the sucrose the following experiment was conducted:

Experiment No. 3.

THE INFLUENCE OF DEXTROSE AND LEVULOSE ON GUM FORMATION.

The series comprising the experiment was as follows:

Series A. 10 per cent sucrose
Series B. 10 per cent dextrose
Series C. 10 per cent levulose
Series D. 8 per cent sucrose; 2 per cent dextrose
Series E. 5 per cent sucrose; 5 per cent dextrose
Series F. 2.5 per cent sucrose; 7.5 per cent dextrose
Series G. 1 per cent sucrose; 9 per cent dextrose
Series H. 8 per cent sucrose; 2 per cent dextrose
Series I. 5 per cent sucrose; 5 per cent dextrose
Series J. 2.5 per cent sucrose; 7.5 per cent dextrose
Series K. 1 per cent sucrose; 9 per cent dextrose

EXPERIMENT No. III.—INFLUENCE OF DEXTROSE AND LEVULOSE UPON THE FORMATION OF GUM.

Culture used, Bacillus vulgatus.

Series	Acidity—20 cc. used; cc. N/10 K. OH required	Reducing Sugar	Single Polarization	Clerget	Gum
A. Control	0.1	....	8.5	8.80	....
A. Inoculated	2.0	4.17	3.9	4.89	1.17
B. Control	1.8	9.76	7.9	....	....
B. Inoculated	3.0	7.4	7.1	....	....
C. Control	2.0	9.08	—11.9	....	....
C. Inoculated	2.5	8.34	—11.1	....	....
D. Control	0.8	1.79	10.0	8.85	....
D. Inoculated	1.9	3.51	6.2	5.44	0.6
E. Control	1.1	4.08	7.5	4.50	....
E. Inoculated	2.7	5.4	7.0	4.29	0.48
F. Control	1.4	6.66	7.7	2.29	....
F. Inoculated	2.6	6.66	6.9	1.45	0.16
G. Control	2.8	7.9	7.2	0.70	....
G. Inoculated	2.3	7.9	7.2	0.70	0.07
H. Control	1.8	5.0	6.8	8.53	....
H. Inoculated	0.6	1.8	1.1	4.31	0.26
I. Control	1.9	7.70	— 5.8	1.02	....
I. Inoculated	1.3	4.25	— 0.8	4.79	0.5
J. Control	2.0	8.34	— 8.8	0.02	....
J. Inoculated	1.5	12.9	— 6.0	2.86	0.40
K. Control	2.0	8.5	—10.5	....	....
K. Inoculated	1.2	8.34	—10.5	....	0.23

From the foregoing results it will be noted that the formation of gum is greatest where the sucrose is highest and decreases almost proportionately with the decrease of sucrose. The variation of dextrose and levulose had no effect and the gum varied just in proportion to the variation of sucrose. Unless there is some peculiar property possessed by these sugars in their nascent stage, as suggested by Smith's theory, which renders them capable of being transformed into gum levan, there is little evidence in the above experiment of the reducing sugar origin of the gum. As one of the accelerating factors in the inversion by invertase is the acidity of the medium, it might be of interest for us to investigate the influence of the titration of the medium upon the formation of levan.

Experiment No. 4.

INFLUENCE OF ACIDITY OR ALKALINITY UPON GUM FORMATION.

In this experiment the regular 10 per cent sucrose solution was used in every series and the only varying factor was the titration of the medium. The acidity was produced by the addition of N/10 sulphuric acid and the desired alkalinity obtained by the use of N/10 KOH. The acid or alkali was added before sterilization and in some cases the heating incident to that process tended to increase the acidity by the liberation of organic acids. Series D was prepared slightly alkaline, but ultimately became slightly acid. Series E remained slightly alkaline throughout the sterilization.

EXPERIMENT No. IV.—INFLUENCE OF ACIDITY OR ALKALINITY UPON GUM FORMATION.

Culture used, Bacillus vulgatus.

Series	Acidity—20 cc. used; cc. N/10 K. OH required	Reducing Sugar	Single Polarization	Clerget	Gum
A. Control.........	0.2	0.0	9.2	9.41	....
A. Inoculated......	1.5	0.75	9.2	9.31	0.38
B. Control.........	1.1	0.0	10.1	10.0	....
B. Inoculated......	1.4	0.47	8.2	8.09	0.29
C. Control.........	1.7	0.0	9.6	9.62	....
C. Inoculated......	1.6	0.55	8.5	8.51	0.14
D. Control.........	2.2	0.0	9.1	9.28	....
D. Inoculated......	2.3	1.08	8.9	9.13	0.21
E. Control.........	0.0	0.0	10.3	10.1	....
E. Inoculated......	1.3	0.29	9.8	9.56	0.38
F. Control.........	(0.2 Alk)	0.0	9.2	9.12	....
F. Inoculated......	1.3	0.40	9.8	9.48	0.33
G. Control.........	(0.1 Alk)	0.00	10.2	10.11	....
G. Inoculated......	1.2	0.00	10.0	10.0	0.26

It was in the slightly alkaline series that the gum development was greatest, indicating that this action, unlike that of inversion, is favored by slight alkalinity. Zopf (*) found this to be true of the formation of dextran by the *Leuconostoc mesenteroides.* This has also been found to be true for the various gum-forming organisms described by other authors. If the formation of gum was dependent upon the previous inversion by the bacteria, we should have expected the greatest gum development in series C., which required 2.4 cc. of the N/10 KOH to 20 cc. O'Sullivan and Thompson (†) in their work on invertase found the optimum acidity varied according to the per cent of invertase in the solution and the temperature at which the inversion was conducted. Under no conditions, however, was inversion found to be stimulated by an alkaline medium. Fermi and Montesano (‡) found that the inversion of sugar would take place to a very slight degree in a medium of slightly alkaline reaction. In this respect it was quite different from the invertase enzyme which is favored by an acid reaction. It may be argued, however, that the formation of gum is different from inversion in its requirements in this respect, yet if nascent reducing sugar is the origin of the gum the development of this substance would be limited to the invert sugar formed. The control in Series E. showed no reducing sugar, so that inversion must have taken place before there could have been any reducing sugars from which the gum was formed. It is obviously true that in the event that the sugar is also inverted before gum formation can take place the amount of gum formed would be limited to the extent of the inverting action. If acidity favored inversion and alkalinity favored gum formation, we could not expect the latter to take place in an alkaline solution where there are no reducing sugars present. As our greatest gum formation occurs in just such a solution, and as this has been found to be true of most of the gum-forming bacteria, we may very probably reach one of the two conclusions—namely, that the action of the invertase of bacteria is unlike that which has been isolated from other sources and which has been very minutely studied; or, second, that the gum is not formed from reducing sugars at all, but directly from sucrose.

---

*Beit. z. Phys. und Morph. Niederer Organismes. Heft 1, 1892, p. 1.
†Loc cit.
‡Cent. Bakt. II, p. 482-542.

Experiment No. 5.

INFLUENCE OF PEPTONE.

The bacteria inducing the gum fermentation of sucrose are somewhat unusual in respect to their nutrient requirements. They are able to develop upon a substratum, which is very poor in nitrogen supply, and hence they are enabled to develop in sugars. As the nitrogenous matter in sugars would be subject to variations resulting from the different degrees of clarification, it might be interesting for us to investigate the influence of this substance on gum formation. Deerr and Norris have found in their work (*) that bacteria were retarded in their development by the presence of more than very small amounts of peptone. The series of experiments was as follows: A standard sucrose solution used for the previous experiments was used here with the per cent of peptone the only varying factor. The series was as follows:

Series A. No peptone
Series B. .01 per cent peptone
Series C. .10 per cent peptone
Series D. .25 per cent peptone
Series E. .50 per cent peptone
Series F. .75 per cent peptone
Series G. 1.00 per cent peptone
Series H. 1.00 per cent ammonium sulphate
Series I. 1.00 per cent asparagine

---

*Bulletin No. 24, The Deterioration of Sugars in Storage, Hawaiian Sugar Planters' Association.

EXPERIMENT No. V.—INFLUENCE OF PEPTONE ON GUM FORMATION.

Culture used, Bacillus vulgatus.

Series	Acidity—20 cc. used; cc. N/10 K. OH required	Reducing Sugar	Single Polarization	Clerget	Gum
A. Control	....	....	9.6	9.86	....
A. Inoculated	0.6	....	9.5	9.60	0.02
B. Control	0.1	....	9.2	9.37	....
B. Inoculated	1.0	....	9.0	9.13	0.27
C. Control	0.2	....	9.1	9.04	....
C. Inoculated	1.4	0.58	8.1	8.60	0.25
D. Control	0.3	....	9.0	9.59	....
D. Inoculated	2.2	6.78	— .3	....	1.3
E. Control	0.6	....	8.8	9.36	0.08
E. Inoculated	3.8	6.16	— .7	0.14	2.33
F. Control	0.7	....	9.0	9.84	....
F. Inoculated	3.2	6.24	—0.2	1.78	1.96
G. Control	1.3	....	8.5	9.28	....
G. Inoculated	4.5	6.66	— .2	1.32	1.59
H. Control	3.6	....	9.0	9.17	....
H. Inoculated	4.0	2.65	6.0	6.62	0.86
I. Control	4.5	....	9.7	9.37	....
I. Inoculated	5.0	5.26	....	....	....

From the foregoing table it will be observed that the greatest amount of gum was produced in Series E, which contained .50 per cent of peptone. The results, as a whole, however, do not tend to show any relation between the presence of peptone and the formation of gum. Up to .50 per cent the addition of peptone seems to have a perceptible affect, but beyond this strength the peptone seems to interfere with the devlopment of gum. The results indicate that .50 per cent peptone is the optimum amount for gum development, although up to this point the increase of gum does not consistently follow the increase of peptone. In Series H and I ammonium sulphate and asparagine were used respectively as a source of nitrogen for the bacteria. Although the gum formation in both cases seems to have been retarded, yet the loss in sucrose and the increase in reducing sugar indicate that the gum was possibly formed and lost through some unknown cause. In a previous chapter where the characteristics of the different species were given it was stated that these species could develop in an albumen-free medium in which asparagine was used as a nitrogen supply. The nitrogen requirement of the organisms both in this case referred to and in Series I of the above experiments seems to have been fully satisfied. This indicates the peculiarity of the organisms and largely explains their ability to develop in the environments offered by the sugars in which they are found.

Experiment No. 6.

INFLUENCE OF CHLORIDES UPON GUM DEVELOPMENT.

In the work of Deerr and Norris on the deterioration of sugars, these authors observed that there was a more or less distinct relation between the inorganic constituents of a sugar and its tendency towards deterioration. Of this inorganic portion or mineral matter the chlorides were thought to be of most importance in their influence upon the keeping qualities of a sugar. Zopf (*) in his work on *Leuconostoc mesenteroides* found that calcium chloride tended to accelerate the fermentation of sugar into dextran by this organism. It seems therefore that it might be well to investigate the influence of chlorides upon gum formed by the species under investigation, so that we might determine its influence in sugars. Both calcium and potassium chloride were used in varying amounts so that the experiment is not only a comparison of varying amounts of chloride but also a comparison of the relative influence of the two substances upon gum formation. The plan of the experiment was as follows:

A standard sucrose solution was used as a basis, the only varying factor being the chloride. The series was:

Series A.	Control; no chloride
Series B.	.10 per cent potassium chloride
Series C.	.25 per cent potassium chloride
Series D.	.50 per cent potassium chloride

---

*Loc cit.

Series E. .75 per cent potassium chloride
Series F. 1.00 per cent potassium chloride
Series G. .10 per cent calcium chloride
Series H. .25 per cent calcium chloride
Series I. .50 per cent calcium chloride
Series J. 1.00 per cent calcium chloride

EXPERIMENT No. VI.—INFLUENCE OF CHLORIDES UPON GUM FORMATION.

Culture used, Bacillus vulgatus.

Series	Acidity—20 cc. used; cc. N/10 K. OH required	Reducing Sugar	Single Polarization	Clerget	Gum
A. Control	0.1	....	9.2	9.57	....
A. Inoculated	1.4	7.14	....	....	1.86
B. Control	0.1	....	9.2	9.54	....
B. Inoculated	1.4	4.54	3.4	5.11	1.16
C. Control	0.1	....	8.8	9.23	....
C. Inoculated	1.4	5.88	2.8	4.42	2.15
D. Control	0.1	....	9.2	9.54	....
D. Inoculated	1.5	2.85	5.6	6.62	0.88
E. Control	0.1	....	9.2	9.54	....
E. Inoculated	1.5	0.62	8.1	8.61	0.51
F. Control	0.2	....	9.2	9.62	....
F. Inoculated	1.3	1.42	7.0	7.77	0.22
G. Control	0.2	0.95	8.2	8.37	....
G. Inoculated	1.4	2.77	8.2	8.77	0.31
H. Control	1.3	3.12	5.7	6.53	....
H. Inoculated	1.2	3.51	5.0	6.33	0.42
I. Control	1.5	4.44	3.4	5.11	....
I. Inoculated	1.3	4.44	3.5	5.19	1.00
J. Control	1.3	4.35	3.5	5.10	....
J. Inoculated	1.3	6.25	3.5	5.02	1.34

Comparing the results of the foregoing table we find that the greatest amount of gum was produced in Series C, which contained .25 per cent potassium chloride. The development of gum seems to be retarded by the presence of large amounts of this substance. Potassium chloride seems to give higher results than calcium. In the case of the experiment with the latter, however, the gum increases almost in proportion to the increase of chloride, but in the former no such constant increase can be observed. According to the above results, it seems that chlorides have little or no influence upon gum formation.

Experiment No. 7.

THE INFLUENCE OF AIR UPON GUM FORMATION.

Teh species constituting the bacterial flora of sugars are facultative anaerobic, but they would be expected to induce a more active fermentation of sugars under aerobic conditions. In order to determine the extent to which this action is dependent upon the air supply, the following experiment was conducted:

A standard sucrose solution was used as in previous experiments. A series of experiments was instituted representing anaerobic natural conditions, and conditions of air in excess. In Series A the anaerobic conditions were obtained by passing hydrogen gas through the flask until the oxygen had been entirely displaced, when the flask was hermetically sealed. In C, the series in which air was supplied in excess, the air was drawn through the flask by a filter pump for five minutes each day of the incubating period.

EXPERIMENT No. VII.—INFLUENCE OF OXYGEN SUPPLY UPON THE FORMATION OF GUM.

Culture used, Bacillus vulgatus.

Series	Condition of Aeration	Acidity—20 cc. used; cc. N/10 K. OH required	Reducing Sugar	Single Polarization	Clerget	Gum
A.	Anaerobic.........	4.3	3.12	3.6	5.30	2.23
B.	Natural......	4.2	6.44	0.2	2.26	2.79
C.	Air in excess.....	9.5	5.90	— 2.9	0.73	4.24

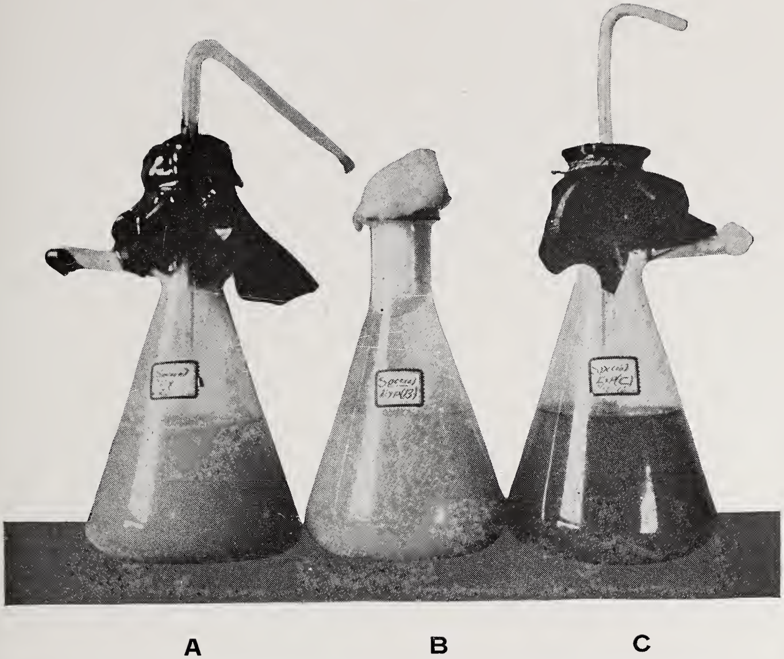


PLATE SHOWING FLASKS USED IN EXPERIMENT VII.
(A) Anaerobic conditions.
(B) Natural conditions.
(C) Conditions of air in excess.

In the above experiments and from the above results it will be noted that the difference in the amount of gum in A and B is not as large as was to have been expected, even though the organism is facultative anaerobic. In Series C the increase of gum over the other series indicates that a copious supply of air is a great factor in gum formation. The results of the experiments are of some significance since they show that the condition of the aeration of a sugar may have a marked influence upon its deterioration. Everything else being equally favorable for the action of the gum formation, we might, in the light of the above experiment, expect a greater deterioration from a well-aerated sugar than where there was no circulation of air. This might, doubtless, explain why certain very low grade sugars do not deteriorate as rapidly as the higher grade sugars. The molasses comprising the film around the crystals may exclude the air, while in the higher grades of sugars there might be a copious supply. It has been observed by other investigators of this subject that the difference in the deterioration of a low and high grade sugar indicated that some condition obtained in the latter which made them deteriorate more rapidly. As the condition of moisture is a very vital one, and as this condition is apt to be more favorable for bacterial action in the lower than in the higher grade sugars, the relative aeration of the two products may be a possible explanation of the difference in the rate of deterioration. We have in many cases observed that where the moisture of a higher grade sugar happens to be increased from any cause until it approximates that of an average raw sugar, a deterioration under such conditions is very rapid and very much greater than in low grade sugars of the same moisture content.

Experiment No. 8.

GUM DEVELOPMENT AS AFFECTED BY DURATION OF INOCULATION PERIOD.

In some of the old culture solutions in which the development of gum had been in progress for some time, it was observed that the gum in certain of these cases showed a tendency to decrease. This may probably be attributed to the hydrolytic action of the acids developed in the process of fermentation. In order to determine the relation between the age of the culture and the disappearance of the gum, as well as to study the rapidity of the destruction of sucrose, the following experiment was instituted: A large quantity of the standard sucrose solution, as used in previous experiments, was inoculated with cultures of *Bacillus vulgatus* and incubated at 37° C. An analysis was made before inoculation and every other day thereafter for three weeks. After this time the analyses were made weekly.

EXPERIMENT No. VIII.—GUM DEVELOPMENT AS AFFECTED BY DURATION OF INOCULATION PERIOD.

Culture used, Bacillus vulgatus.

Age of cult.	Acidity, 25 g.; required, cc. N/10	Reducing Sugar	Single Polarization	Clerget	True Sucrose (Corrected Clerget)	Gum
....	....	....	9.2	....	....	......
2 days............	2.5	2.33	5.6	6.74	6.04	1.05
4 "	2.8	5.56	2.0	4.83	3.65	1.77
6 "	....	6.78	0.0	2.30	.11	3.28
8 "	2.8	7.28	— 0.4	2.30	.76	2.82
10 "	2.6	6.90	— 0.4	1.63	....	2.59
13 "	2.6	6.90	— 1.3	1.85	....	......
15 "	2.3	7.14	— 1.2	1.35	....	1.98
17 "	2.2	7.14	— 1.3	2.36	....	......
20 "	2.4	7.14	— 1.3	1.66	....	1.34
22 "	2.1	7.14	— 1.8	1.23	....	1.88
28 "	3.0	7.84	— 1.8	1.16	....	(2.37)
34 "	3.2	7.28	— 2.1	1.00	....	1.69
42 "	3.6	7.84	— 2.2	0.26	....	0.65

A glance at the foregoing table shows that the sucrose in the solution was completely destroyed by the tenth day, and that the analysis on the second day showed a concurrent development in both gum and reducing sugars. The amount of gum was highest on the sixth day, after which time it decreased until the last analysis, which showed only .65 per cent. The reducing sugar, on the other hand, continued to increase during the entire period observed. Under the head of true sucrose, where the results are given as corrected Clerget, it will be seen that the sucrose was entirely destroyed on the sixth day. It is quite interesting to compare the true sucrose estimated in this way with the Clerget and the single polarization: Where 3.28 per cent of gum occurs the difference between the Clerget and corrected true sucrose is as high as 1.19 per cent. The Clerget never shows an entire destruction of sucrose, owing to the fact that as long as gum is present there will be a sucrose reading. The investigators of the subject of bacterial deterioration of sucrose have found that the various bacteria investigated in this connection have never brought about an entire destruction of sucrose as measured by the Clerget method of analysis. This experiment shows very clearly how they might have been in error in their assumption. The results very clearly explain how they might easily have been misled in their observation. On the following pages will be observed two charts showing the loss in sucrose and increase in reducing sugars and gums as tabulated in the foregoing table.

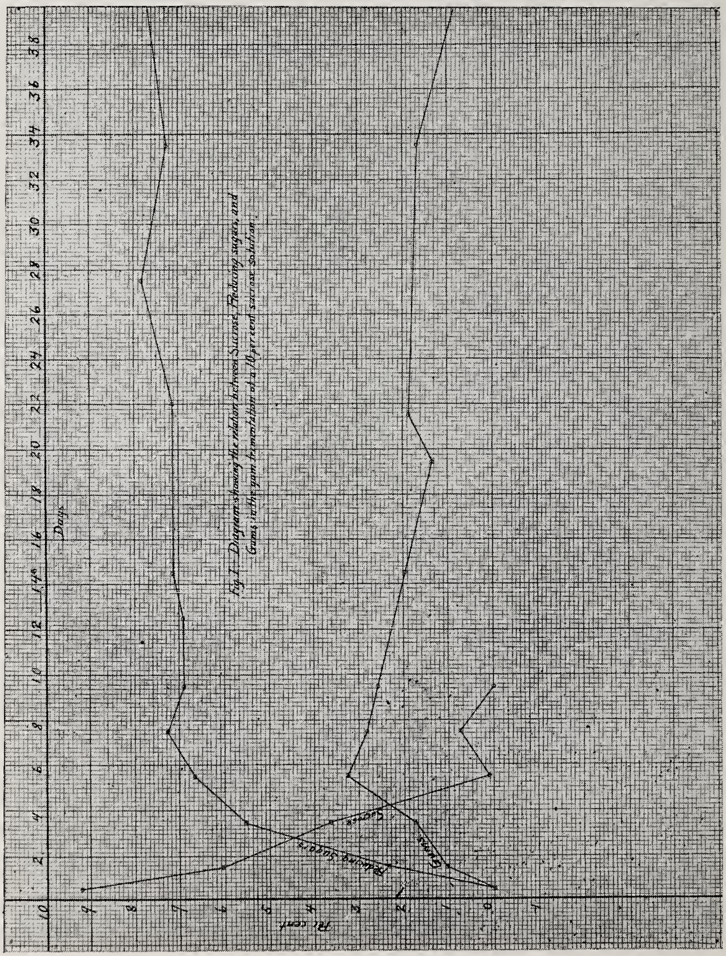


Fig. I—Diagram showing the relation between Sucrose, Reducing sugars, and Gums in the gum fermentation of a 10 per cent sucrose solution.

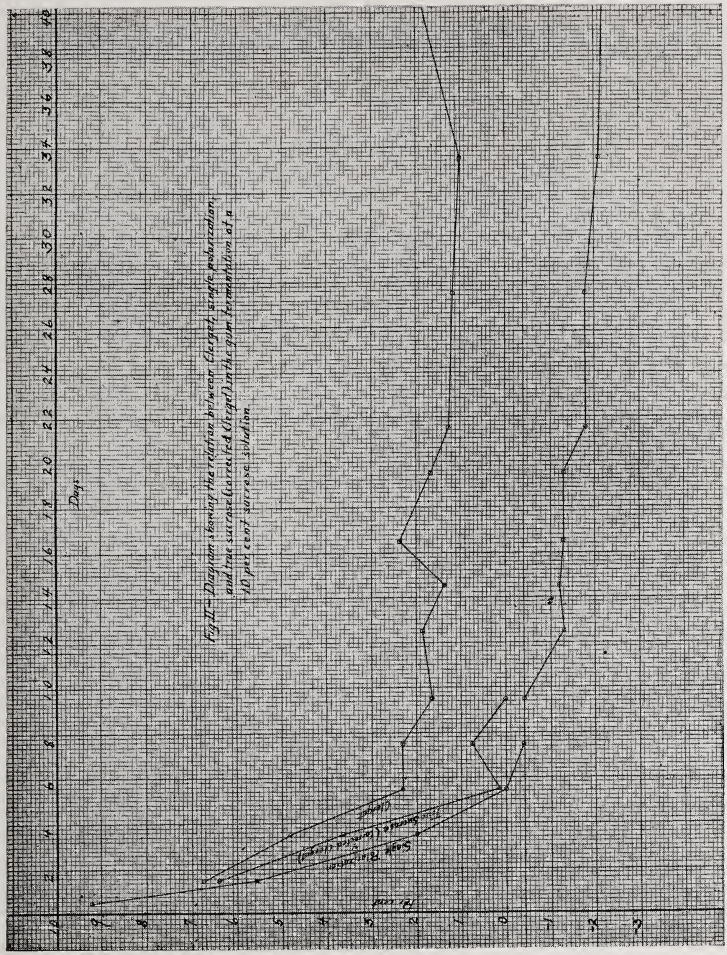


Fig II — Diagram showing the relation between Clerget, single polarization, and true sucrose (corrected Clerget) in the gum fermentation of a 10 per cent sucrose solution.

The second chart shows the relation between the single polarization, Clerget and true sucrose (and a corrected Clerget) in the above experiment. It will be noticed that the Clerget is consistently higher and the single polarization lower than the true sucrose. This explains very clearly why the results from our experiments with inoculated sugar showed an increase in sucrose from the Clerget method of analysis, and a loss as measured by single polarization. In our corrections for gums by means of which we determine our true sucrose it must be remembered that any method for the quantitative determination of gum is subject to error. The difficulty of removing it from the flask in which it is precipitated and the many other ways in which an error may exist render an absolutely accurate determination hardly to be expected. We do not believe that the factor of error is such as to materially change the relation between the respective curves of sucrose, reducing sugars and gums. The diagram showing the variation of single polarization and Clerget from the true sucrose shows that in the presence of levan the factor of error is larger for the sucrose Clerget, than in the case of the single polarization. From this it will be seen that the Clerget method for determining sucrose under such condition is very unreliable. Referring to the diagram No. 2, it will be noted that the Clerget reading on the sixth day is 2.30 per cent where the single polarization gives zero sucrose and where true sucrose is .11. The single polarization is .11 low, while the Clerget is 2.29 per cent high. In the presence of appreciable quantities of levan the single polarization will probably be the more reliable of the two methods.

Experiment No. 9.

ISOLATION OF GUM-FORMING ENZYMES.

In studying the formation of levan by the bacteria of sugars there is much to suggest extracellular enzyme action. Were the gum formed intracellularly it is believed that it could diffuse from the cell only with the greatest difficulty and if it originated intracellularly it seems that there would be little difficulty in demonstrating its presence as a capsule enveloping the organisms. But, as a matter of fact, the presence of a capsule was very rarely observed in our study of the species forming levan. Many efforts were made to demonstrate the presence of a capsule and almost all of the special staining methods were used with little success. As most of these methods are based on the fixation of the capsule by acids, it was hardly to be expected that they would be effective in this case where the capsule, if present, would most likely be soluble in such a solution. As levan is precipitated by alcohol in an alkaline solution, a method of staining was originated which had this as a basis. The cover glass containing the film was immersed in 95 per cent alcohol, which had first been rendered alkaline to phenolphatalein by sodium hydroxide. The alcohol was allowed to act for three minutes, during which time the cover glass was gently heated on a gas flame. After the stain had been heated the cover glass was then washed in a physiological salt solution, and then mounted in the usual way. Occasionally this method gave good results and it was the only method that ever succeeded in our hands. As the capsule wherever such a formation occurs is the levan formed by the organisms, the above method ought to have demonstrated this gum as a capsule if it surrounded the bacteria. The rareness of our success in using this method very strongly indicated that the levan formed by the organism does not surround the organism as a capsule, but is likely to be formed away from the cell. In certain cases where a large amount of gum has formed in the solution from which the mounts were made, the capsule formation was observed. Even here, however, it is most probable that the gum which was stained was not a true capsule but only a part of the gum that had enclosed the organism. The question as to whether the gum is formed by an extracellular or an intracellular enzyme has been answered differently by different investigators on this subject.

Greig Smith (*) in his report seems inclined to the former opinion, while Marshall Ward and Reynolds Greene (*) believe that their organism produced the gum intracellularly, and that the gum occurring in the medium in which the organism grew was really the diffluent capsule of the cell. Lehmann and Newman (†) and Ritsert and Happ are also inclined to favor the extracellular theory. In order to determine the manner in which the gum was formed effort was made by the author to isolate the enzyme capable of producing levan from sugars. Believing that if there was such an enzyme it would very likely occur outside of the bacterial cells in solution undergoing gum fermentation and that it would be detected there at some stage of the fermentation period, the plan was to prove its existence by means of the porcelain filter. The standard sucrose solution was placed in an Erlenmeyer flask and inoculated with cultures of *Bacillus vulgatus.* After different periods of incubation varying from 24 hours to 10 days, the cultures were killed with thymol and the liquid filtered through a porcelain filter. The filtrate was then introduced into a flask containing standard sucrose solution to which toluene had been added to prevent contamination from other sources. In some cases chloroform was used as a means of killing the cultures and in others the cells were not treated with any antiseptic at all before filtering. The purpose of using the antiseptics was to bring about such injury to the cells that in the event of the enzyme being strictly intracellular this treatment might cause them to diffuse into the surrounding medium. In some cases a gum development followed the inoculation with this filtrate, but in the majority of these, contaminations were found to have been responsible for them. Thinking that the presence of a large amount of gum in the culture solution tended to hold in check the filtration of the enzyme through the porcelain filter, smaller percentages of sugar were tried in the solutuion in order to reduce the per cent of gum formed; but this change did not seem to correct the difficulty. The failure, however, to detect an enzyme by such means neither disproves the existence of the enzyme nor even the extracellular nature of its action. It is perfectly conceivable, of course, that an enzyme may be extracellular in its action and yet not filter through porcelain. There is, in fact, no relation between the zone of action of an enzyme and its behavior towards the porcelain filter. Although all of the known enzymes which have been proven to be extracellular in their action have been demonstrated to be so by means of the porcelain filter, it, of course, does not affect the theory of an extracellular enzyme being nonfilterable through porcelain. The work was therefore continued, but a different method was adopted. We next tried to isolate the enzyme from cultures on solid medium and for this purpose we used ordinary plain agar which was inoculated with bacillus vulgatus and plated out in large moist chambers. In our experiment five or six of these chambers were half filled with agar and inoculated and then incubated at 37.5 C. for a week or ten days. At the end of this time a vigorous growth had covered the entire surface of the chambers. This surface portion of the medium which was composed of the growth of the bacillus was scraped off with a sterile glass slide and placed in a large mortar, where it was triturated with powdered glass until it was of the consistency of a very finely ground mass. This large mass of the growth of the organism was next dissolved in distilled water, after which it was precipitated with alcohol. The alcoholic precipitate was of a very flocculent nature and it settled out quite rapidly after about five volumes of alcohol had been added. The precipitate was then taken and introduced into a flask containing 250 cc. of the 10 per cent standard sucrose solution, to which 25 per cent of toluene was added to prevent the growth of any micro-organisms. After the flask was inoculated it was placed in an incubator at 37.5° C., where it was kept for several days. As a control over the experiments flasks containing the same quantity of the sugar solution were treated as follows: One was left uninoculated and untreated as a control upon the sterility of the solution used; another was treated with the same per cent of toluene as used in the first case, and then inoculated with the culture of *Bacillus vulgatus* as a control on the efficiency of the amount of toluene used as a preventive of cell development. If levan were produced under the last condition of inoculation it would naturally be assumed that the amount of toluene added had been insufficient and conclusive proof of the action of an enzyme would in that case be lacking, even though positive results were obtained from the inoculation with the alcoholic precipitate. Still another flask was used as a further control of the experiment. In this case the solutuion was untreated and inoculated from the same cutlure as used in previous cases. The object of this control was to demonstrate the ability of the culture to produce gum in the solution used. If the alcoholic precipitate contained an active enzyme we should expect the results from the above experiment to be as follows:

---

*Loc cit.

†Text Book of Bacteriology. Lehmann and Newman.

Flask No. 1—No bacteria observed in microscopical examination; gum and reducing sugar formed.
Flask No. 2—No bacteria observed; no gum; no reducing sugars.
Flask No. 3—No bacteria observed; no gums and no reducing sugars
Flask No. 4—Bacteria; gums and reducing sugars

The results, however, were surprising in this particular, that with but one exception an enzyme action was conclusively shown. This exception was with Flask No. 2, which was inoculated from the culture of bacillus vulgatus and in which gum had been formed in small quantities. At first thought this was taken as an indication of the lack of a sufficient amount of toluene to prevent the development of the bacteria introduced. A microscopical examination, however, repeatedly failed to show any indication of bacterial activity. Although a few bacterial cells were observed these did not appear in a healthy condition, but showed marked signs of deterioration and no motion could be observed in a hanging drop. The results of the experiment were, however, discarded even though the flask inoculated with the alcoholic precipitate of the culture showed gum development associated with an absence of any bacteria. The experiment was repeated with increasing amounts of toluene until the amount of toluene used was as high as 50 per cent, but even this excessive amount of antiseptic did not change the results and gum formation continued to follow the inoculation with the old culture, as well as that from the alcoholic precipitate. The consistent gum development which followed inoculation from the old culture where the amount of toluene used had a theoretical antiseptic value far greater than should have been necessary to prevent the development of bacteria, indicated that the culture medium introduced owed its gum-forming power to some other source than that of the bacteria introduced. The explanation of results are perfectly obvious, particularly in view of the absence of bacteria occurring under this condition. In the old agar cultures the enzyme had been secreted and had become diffused throughout the medium. When a small portion of this culture was transferred to the solution enough of the enzyme was introduced therewith to bring about the gum formation. Just as when the enzyme is introduced in the form of an alcoholic precipitate, gum was formed where the organism had been introduced. This, however, was always much less than where the alcoholic precipitate was used, showing that the difference of condition was only one of degree. In order to prove this point, another experiment was carried out in which small portions of this same agar culture, upon which no growth occurred, was used in inoculating the sucrose solution. With a sterile platinum loop small portions of the agar were taken from the surface of the culture flask at a point as far removed as possible from the growth of the bacteria. In this case it was found that gum development followed this means of inoculation just as in the case where that portion of agar containing the growth of the organism was used. Toluene was used in the same amounts as in the former case. Analyses of these experiments always showed the presence of both gum and reducing sugar where the uninoculated control solution contained neither. It is very evident, therefore, that the enzyme thus discovered breaks down sucrose into gum and reducing sugar. In the light of this experiment and in further consideration of the preponderance of evidence that we have previously noted in support of this enzyme theory, it seems thoroughly consistent with the facts to state that gum levan is formed by an extracellular enzyme to which we give the name *Levanase.* The decomposition of sugars by this enzyme is probably as follows:

$$C_{12}H_{22}O_{11}=C_6H_{12}O_6+C_6H_{10}O_5$$

As will be noted this reaction shows a new decomposition of sucrose. It is very probable that dextran is also produced by an enzyme (*).

Experiment No. 10.

INFLUENCE OF NASCENT LEVULOSE AND DEXTROSE.

Our previous experiments in this part of our investigations have been directed towards proving that sucrose is the origin of the gum levan formed by the sugar bacteria in their action upon sucrose. We have shown that the formation of levan always accompanies the destruction of sucrose and that the presence of sucrose is essential to this gum formation. We have further shown that the bacteria were not able to produce this gum from reducing sugars in their natural state. We have shown further that the destruction of sucrose and the accompanying development of gum takes place under conditions of concentration of sugars and the alkalinity of the solution that have been found to be highly unfavorable to the action of invertase. These facts have led us to propose a theory of the direct change of sucrose into levan and reducing sugars. This hypothesis seems, in the light of the above enumerated results, to be the only one that completely fulfills the conditions of our experiment. In order to definitely prove, however, the effect of nascent levuluose and dextrose upon the gum formation, as suggested by Grieg Smith in his investigations of the subject, the following experiment was planned:

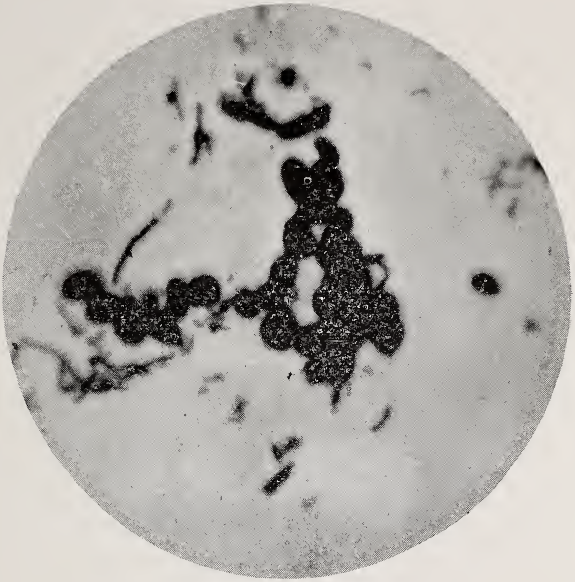
---

*The properties of this new enzyme are now being investigated and will form a subject of a publication that is to follow in the near future.

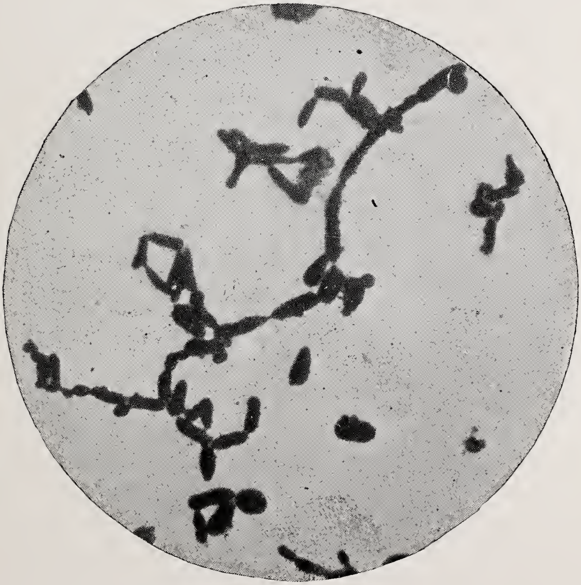
The standard sucrose solution, as used in previous experiments, was inoculated with yeast and cultures of the Bacillus vulgatus for the purpose of determining whether the invert sugar formed by the yeast would increase the gum formation of the bacillus. The series used in the experiment was as follows:

Series A. 2 flasks inoculated with *Bacillus vulgatus.*
Series B. 2 flasks inoculated with yeast alone.
Series C. 2 flasks inoculated with both yeast and *Bacillus vulgatus.*

These flasks were placed in the incubator and incubated at 37.5°C, and the first analysis was made at the end of the third day. If the bacteria formed levan from nascent levulose or dextrose we would expect more gum where the yeast and gum-forming bacteria were used. There would certainly be more inversion in that case, because yeasts are known to have a far greater power to invert sucrose than any species of bacteria so far studied. If less gum was formed in Series B than in Series A, it shows that the nascent levulose and dextrose theory is inconsistent with the facts, provided, of course, that the presence of the yeast did not interfere with the development of the bacteria. The photograph on the opposite page shows that the development of bacteria in Series B was certainly not interfered with, but the formation of gum under this condition of double inoculation was considerably less than where the bacterial culture were used alone.



No. 1.



No. 2.

1. Mount made from solution in Series B, Experiment X, showing double inoculation with yeast and Bacillus vulgatus.
2. Mount made from solution in Series C, Experiment X, showing inoculation with yeast.

EXPERIMENT No. X.—INFLUENCE OF NASCENT LEVULOSE UPON THE FORMATION OF GUM.

Culture used, Bacillus vulgatus.

Series	CULTURE	Acidity—20 cc. used; cc. N/10 K. OH required	Reducing Sugar	Single Polarization	Clerget	Gum
	Control	0.7	....	9.3	9.73	.....
A. (1)	B. IV	4.1	4.25	4.5	5.89	2.69
B. (1)	B. IV and Yeast	8.5	7.02	— 0.8	2.08	1.47
C. (1)	Yeast	6.6	7.28	— 0.6	2.32	.....
	Control	0.8	....	9.3	9.44	.....
A. (2)	B. IV	3.8	6.78	— 0.3	1.88	4.85
B. (2)	B. IV and Yeast	9.1	2.27	— 2.8	....	0.39
C. (2)	Yeast	5.4	6.25	— 4.5	....	.....

In looking over the table of results we find that on the third day, as shown by Analysis No. 1, the amount of reducing sugar formed in Series B, in which both bacteria and yeast were used, was almost double that of Series A, where the bacterial culture was used alone. Under the head of gum we find that the relative amount of gum development in the two cases was exactly opposite, the double inoculation producing 1.47 per cent where the bacteria alone produced 2.61 per cent, or about twice as much. From this it appears that the amount of gum formed where the inversion of sucrose was in progress was decreased in almost direct proportion to the amount of invert sugar formed. In other words, where the sucrose was inverted by the yeast it was lost entirely in so far as it formed a basis for the development of gum by the organism. We might state, therefore, that in solutions undergoing inversion the development of gum will be inversely proportionate to the inversion of sucrose. The first analysis was made after three days, which is indicated in the table by the number placed after the series letter. The first analysis was for the purpose of showing the extent to which the bacteria were provided with adequate amounts of nascent dextroes and levulose throughout the period of fermentation. From this analysis it will be seen that the yeast in Series B had formed as much reducing sugar—or almost as much—as in Series C, where the pure culture of yeast was employed. In the second analysis, which was made at the end of a week, it is interesting to note that the reducing sugar in B had dropped from 7.2 per cent in the first period to 2.27 in the second, but this loss in reducing sugars is explained by the increase in acidity from 8.5 per cent in the first, to 9.1 per cent in the second. The bacteria had utilized the reducing sugar formed, not in the development of gum, but in the formation of acid. It seems evident from the above that the nascent levulose and dextrose formed from the inversion of sucrose is no more favorable for the development of gum than what we have found to be true for reducing sugars in their natural condition. This experiment is, however, conclusive proof, we believe, of our theory of the direct transformation of sucrose into gum and reducing sugar. In comparing the relative loss of sucrose caused by the yeast and the gum-forming bacteria we find that the destruction of sucrose is almost as rapid in the latter case as in the first.

Experiment No. 11.

GUM DEVELOPMENT IN 10 PER CENT SUCROSE SOLUTION WITHOUT ADDITION OF NUTRIENT ELEMENTS.

In our study of the characteristics of the species constituting the bacterial flora of sugar products we had occasion to observe the peculiarity of these organisms in respect to their nutrient demands. We find that they can grow vigorously upon non-albuminous sub-strata, which explains to a large extent their ability to develop upon sugars. We were unable to prove by direct methods that the gum levan was formed in such products, although we had sufficient evidence to convince us that the deterioration that had taken place in sugars was through its transformation into gum. In order, therefore, to determine whether gum development would take place in a medium as poor in nutrient value as the sugars in which we have found the species occurring, we planned the following experiment: 10 per cent sucrose solutions were made by adding to distilled water the desired amount of different samples of sugar. Beginning in Series A with the lowest grade sugar on hand, we increased the purity of our solution to Series G, where we used a refined sugar. These solutions were then inoculated and incubated in the usual way. The analyses were only qualitative, as we only wished to determine whether gum formation had taken place.

EXPERIMENT No. XI.—GUM DEVELOPMENT IN 10% SUGAR SOLUTIONS WITHOUT ADDITION OF NUTRIENT SALTS.

Culture used, Bacillus vulgatus.

SERIES	No. of Sugar Sample used	Polarization of Sucrose	Identified Gum
A............................	33	68.90	—
B............................	89	88.90	—
C............................	75	92.90	—
D............................	59	94.55	+
E............................	31	96.00	+
F............................	64	98.70	+
G............................	95 Refined sugar	99.5	+

It will be noted from the foregoing table that levan could not be identified where the low grades of sugar were used, but was identified in all the high grade series, even in the case where refined sugar was a source of the sucrose. It is, of course, fair to assume that the conditions were more favorabale for gum development in the cases where the lower grades of sugar were used than in those where higher grades were the source of the sucrose. It is mostly likely that levan was formed in these cases, but it could not be identified on account of the impurities. This was just the difficulty that was encountered in our work on sucrose. In certain cases we have added pure levan to low grade sugars and have been unable to identify it through our methods of separation, on account of impurities that behaved similarly to alcoholic precipitation. The experiments indicate that the factor of moisture would be more likely to influence the bacterial deterioration of sugars than the nutrient supply.

EXPERIMENT NO. 12.

GUM DEVELOPMENT IN BOUILLON.

We have found in the course of this investigation that inversion of sucrose plays but little part in the bacterial deterioration of sugars. According to Fermi (*) the invertase enzyme is rarely possessed by bacteria. In his experiments upon various organisms he discovered that comparatively few bacterial species caused inversion of sugar. Among these are mentioned *Bacillus megatherium,* the Kiel bacillus, and several others. Vignal (†) found that *Bacillus mesentericus vulgatus* possessed such an enzyme. According to Zopf (‡) the *Leuconostoc mesenteroides* also secretes an invertase enzyme.

Fermi found in his work on this subject that some bacteria inverted sucrose in slightly alkaline solution, and others only in acid solution. He showed further that invertase from some of the species passed through a porcelain filter, while that of others was retained. In the foregoing experiments sucrose bouillon and sucrose glycerin bouillon, both containing about 5 per cent sucrose, were used for the purpose of studying the extent to which inversion would take place in such a medium. The medium used, as well as the condition of the experiment, was approximately the same as those of Fermi in his work.

EXPERIMENT XII.—GUM DEVELOPMENT IN BOUILLON.
Series A. Plain Bouillon.
Series B. Glycerin Bouillon.

Series	Culture used	No. cc. used	cc. N/10; KOH required	Reducing Sugar	S. Pol.	Clerget	Gum
A.	Bac. subtilis.............	20	5.4	....	4.0	4.96	.....
A.	Bac. megatherium........	20	5.4	....	4.5	5.18	.....
A.	Bac. mes. fuscus.........	20	5.7	2.85	—1.1	.33	0.16
A.	Bac. mes. vulgatus.......	20	3.8	8.0	2.7	2.02	0.18
A.	Bac. liodermos...........	20	6.1	1.69	—1.0	0.58	1.22
A.	Control.......	20	2.2	....	4.1	5.3	.....
B.	Bac. subtilis.............	20	5.0	....	4.0	4.93	.....
B.	Bac. megatherium........	20	4.9	....	0.4	1.37	.....
B.	Bac. mes. fuscus........	20	6.2	1.92	0.6	2.27	0.21
B.	Bac. mes. vulgatus.......	20	3.3	1.13	2.4	4.38	0.75
B.	Bac liodermos...........	20	6.0	2.0	—1.1	0.67	1.42
B.	Control	20	2.3	....	4.0	5.18	.....

*Loc cit.

†Green's Annals of Botany, Vol. VII, p. 120.

‡Virchow's Archives, Vol. CXXV, p. 156.

A glance at the results of the experiment shows that the action upon sucrose under this condition might easily be mistaken for a typical inversion, as the loss in sucrose is accompanied by an increase in reducing sugars, which under ordinary conditions would very likely be considered the result of inversion; and particularly since the presence of the gum that had been formed would hardly be suspected. It is probable, therefore, that certain of the examples of inversion given by Fermi might really have been cases of gum fermentation. It will be noticed that neither gum nor reducing sugars was produced in the inoculation of *Bacillus subtilis* or *megatherium,* although the difference in the Clerget and single polarization in these cases strongly indicates the destruction of sucrose in a similar way. *Bacillus subtilis* is mentioned by some authors as a species capable of inverting sugar, and it was tried in this experiment in order to determine whether its action upon sucrose was similar to that of the organisms causing the gum fermentation of sucrose. It seems that *Bacillus megatherium* may be classed as an inverting bacteria, although a race of this organism that we have discovered in sugars causes the gum fermentation of such products.

PART IV.

PRACTICAL APPLICATIONS OF THE RESULTS, AND CONCLUSIONS.

Having previously shown in this report the nature of the bacterial deterioration of sugars, and having duly considered the characteristics of the species inducing this action, it might be of advantage to us to consider some practical aspects of the question as suggested by our previous experiments. As the deterioration of sugar is conclusively shown to be due to the action of this bacteria, it would be of some significance to discover the avenues through which such products become contaminated with these species. The seriousness of this loss would certainly warrant us in looking into the matter with the view of determining just how we may reduce the contamination through any possible modification of our present methods of manufacture. With this idea in view, certain experiments were instituted by this department during the season of 1909. These experiments were of the nature of a bacteriological control of the station sugar plant throughout the entire milling season. The purpose of the work was chiefly that of determining whether the contamination of the raw juices in the sugar manufacture resist the temperatures of the various processes during manufacture. It was first contemplated that the work would determine the different species peculiar to the different products of the mill. This work was carried on throughout the entire season during which time about ten ''runs'' were tested. It was desired to have the results as representative of average conditions as was possible, and to this end every possible precaution was made to eliminate errors incident to accidental contamination. Sterile flasks were used in collecting all of the samples, and the plating of the various samples promptly followed the sampling so as to eliminate the error of development of bacteria between the time of taking the sample and the subsequent plating. The samples were plated out upon a sucrose agar, as this medium had been shown by special experiments to be more favorable to the development of the species than the ordinary plain agar. The syrups and massecuites were collected with great care and were usually taken just as they were made, and the sugars were taken directly from the centrifugal, and all

AVERAGE OF RESULTS FROM BACTERIOLOGICAL CONTROL WORK AT THE SUGAR HOUSE OF THE EXPERIMENT STATION, SEASON 1909. NINE "RUNS."

PRODUCT	No. of Organisms per gram or cc.	SPECIES	Presence of Species of Economic Importance
Raw Juice	280,000	Yeasts, Molds, Bact.	+
Sulph. Juice	35,000	Yeasts, Molds, Bact.	+
Limed Juice	37,500	Bact. predominating	+
Defecated Juice	750	Sugar Group Bact. E	+
Syrup	400	Sugar Group Bact. E	+
Massecuite	450	Sugar Group Bact. E	+
Sugars	600	Sugar Group Bact. E	+
Molasses	35,000	Mixt. Contam.	+
Wash Water	25,000	Mixt. Contam.	+
Filter Press Cake	1,500,000	Mixt. Contam.	+

possible chances of contamination were eliminated. Generally considered, the work was carried out with the least possible chance of error and the results, although showing in certain cases variations that are not easily explained, yet we could not expect absolutely consistent decreases in the organisms occurring in the different products. We may greatly reduce the number of organisms in the product in a certain stage of its manufacture, while subsequent exposures to the atmosphere might result in such a contamination as would show a slight increase over the previous product. The significance of the result, however, is not so much in the variation of the number of organisms in the various products, but it is that it is shown that in no stage of the manufacture is the product entirely free from micro-organisms.

BACTERIOLOGICAL ANALYSES OF SAMPLES FROM A SUGAR REFINERY.

NAME OF SAMPLE	Dilution Employed	No. of Organisms per gram or cc.	Presence of Species of Economic Importance
Raw Sugar	1:100	1,000	+
Raw Washings	1:1000	5,000	+
Washed Sugar	1:100	2,000	+
Melted Washed Sugar			
Def. Wash. Sugar and liquor	1:200	800	+
Bag Filtered Wash. Sugar and liquor.	1:1000	3,000	Moulds & Bacteria
Light Sweet Water			
Clear Filtered Liquor	1:1000	1,000	+
Defecated Washings	1:000	6,000	+
Bag Filtered Washings	1:000	5,000	+
Dark Sweet Water	1:2000	8,000	+
Char. Filt. Washings	1:400	8,000	+
Mud Water	1:2000	400,000	+
Press Cake	1:2000	No Development	
Press Water			
Conc. Sweet Water	1:1000	20,000	+
Granulated Magma	1:100	300	+
Granulated Syrup	1:1000	5,000	+
Wet Granulated Sugar	1:50	150	+
Dry Granulated Sugar	1:50	150	+
Remelted Magma	1:50	200	+
Remelted Syrup	1:1000	25,000	+
Undefecated liquor	1:500	10,000	+
Remelted Sugar	1:500	500	+
Car Sugar	1:500	3.000	+
Barrel Syrup	1:100	8,000	+
Car Syrup, two weeks in hot room	1:100	400	+

From the foregoing table it will be observed that the sugars as they are made are contaminated with the deteriorative type of bacteria which begin their work of destroying sucrose immediately, provided that the conditions of moisture are favorable. The resistance of the spores in these organisms which we have found to withstand a temperature of 212° F. for two hours renders it almost impossible to destroy them in the process of sugar manufacture. We may greatly reduce the number of them occurring in our products if we would practice cleanliness in our mills to the degree that science has taught us to apply to all of our food-manufacturing industries. Just as the keeping quality of milk and other dairy products is largely dependent upon the cleanliness of the conditions in which it is made, so the keeping of sugar likewise depends upon the conditions surrounding its manufacture. Referring to the table it will be observed that the defecation of the juice removes about 98 per cent of the organisms occurring in the undefecated product. It is to this remaining 2 per cent and its elimination that our attention should be directed. The use of antiseptic washes for the mills and tanks of the sugar house is to be strongly recommended. The drying of sugars is also to be recommended as a means of preventing this deterioration. In our experiments upon the influence of the acidity or alkalinity upon the gum formation, we found this action to be accelerated by a slight alkalinity of the media. In the sugar manufacturing industry we find opinion current that the deterioration of sugars is due to inversion by micro-organisms. This is no doubt one of the reasons why the refineries will work as far as possible with alkaline solutions. As our investigation has shown that the deterioration of sugars is not due to inversion, but to a gum fermentation which is favored by slightly alkaline solution, it seems that modifications of this prevalent refining method might be well worth considering. So far as the deterioration of micro-organisms is concerned, there can be little doubt that the loss through inversion from this source would be small compared to that resulting from the action described in this report. In some cases where persistent heating is practiced, the loss from inversion in an acid solution might be greater than that caused by micro-organisms in the same solution when alkaline. Lewton-Brain and Norris claim that no deterioration can take place in a sugar containing less than one per cent of moisture. Our general experiments have tended to confirm their results. An experiment of a similar nature to those conducted in connection with the operation of the sugar house has also been applied as a bacteriological control of a sugar refinery. The table of results of these experiments is also given on the following page. From this table it will be observed, under the head of The Presence of Species of Economic Importance, that such species were observed throughout the entire refining process. The title of this column applies generally to the species that cause the gum formation from sugar. The table of results in this case represents only one set of products. It is on this account of little value so far as the quantitative results are concerned. The qualitative analysis is very significant, however, since it shows that the gum-forming organisms occur in all of the various stages of the process of sugar refining, just as we have previously observed to obtain in the case of the manufacture of raw sugars.

SUMMARY OF CONCLUSIONS.

1. The deterioration of sugars is caused by a group of bacteria comprising the well-known potato group of bacilli.
2. The destruction of sucrose induced by these organisms is by means of an enzyme which we have termed *Levanase.* This enzyme is extracellular in its action and breaks down sucrose as follows:

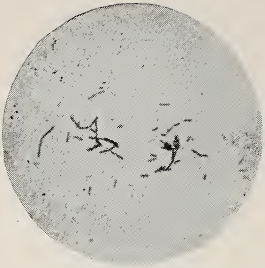
$$C_{12}H_{22}O_{11}=C_6H_{12}O_6+C_6H_{10}O_5$$

3. The formation of levan in sugars introduces an error in both the single polarization and Clerget methods of determination of sucrose. This error causes a decrease in the single polarization of .6V for every 1 per cent of levan, and an increase of .67V for Clerget in the presence of 1 per cent of gum. Owing to this factor of error, a sugar in which gum formation has taken place would show an increase in sucrose by the Clerget method of determination.
4. The spores of the species causing deterioration of sugar are highly resistant to heat and survive different processes of manufacture, thus forming in part the contamination of the final products.
5. The gum formation of sucrose is favored by slightly alkaline reaction of the medium.

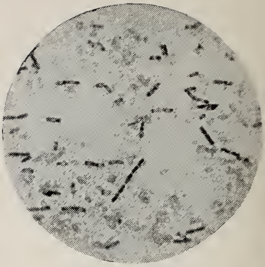
BIBLIOGRAPHY.

1. Binaghi, Ueber die Bedeutung der Kapseln Bacterien. Cent. fur Bakt. Zweite Abt., Vol. IV. (1898.)
2. Brain, Lewton and Noel Deerr—The Bacterial Flora of Hawaiian Sugars. Bulletin 9, Hawaiian Sugar Planters Station.
3. Davenport—Experimental Morphology.
4. Deerr, Noel, and R. S. Norris—The Deterioration of Sugars in Storage. Bulletin 24, Hawaiian Sugar Planters Station.
5. Dodson, W. R.—Relation of Bacteria to the Inversion of Crystallized Sugars. Bulletin 75, Louisiana Experiment Station.
6. Fermi—A Contribution to the Study of Micro-Organisms Secreting the Diastatic and Inverting Ferments, Vol. XII, 1892, 713-715.
7. Fermi and Montesano—Die von den Microben bedingte Inversion des Rohrzuckers, Cent. fur Bakt., Vol. II, pp. 432-542.
8. Fisher, Emil—Methode zur. Herstellung. der Invertase. Zeit. fur Phys. Chemie., p. 75, Vol. XXVI, 1898.
9. Fisher, Gustav—Vorlesungen ueber Bakterien.
10. Glaser, Fritz—Bakterium gelatinosum Betae. Cent. fur Bakt., Vol. XIV, 1893, Zweite Abteilung.
11. Happ—Bacteriological and Chemical Investigation of a Slime Ferment.
12. Hudson, C. S.—On the Methods and Preparation of Invertase. Bulletin Bureau of Chemistry, U. S. Dept. of Agriculture.
13. Lafar—Technische Mycologie.
14. Laxa—Uber das sogenannte Clostridium gelatinosum. Zeit fur Zucker industrie in Bohmen. Band 26, 1901, S. 122.
15. Metcalf, H.—Bakterium teutleum.
16. Migulu—System der Bakterien.
17. O'Sullivan & Thompson—Invertase, a Contribution to the History of an Enzyme or Unorganized Ferment. Trans. Chem. Soc. London, Vol. LI, 1890, p. 234.
18. Ritsert—Bacterium gumosus. Ber. der deutschen Pharmazeutischen. Gesellschaft, Band 1, 1891, pp. 389, 390.
19. Schmidt und Weis—Die Bakterien.
20. Shorey—The Deterioration of Sugars by penicilium glaucum. Jour. Soc. Chem. Ind., Jan., 1898.
21. Smith, Erwin F.—Bacteria in Relation to Plant Diseases.
22. Smith, R. Greig—The Gum Fermentation of Sugar Cane Juices. Proc. Linnean Soc., New South Wales, Vol. XXVI.
23. Smith, R. Greig—The Deterioration of Raw and Refined Sugar Crystals in bulk. International Sugar Jour., Vol. IV, 1902, pp. 430-433.
24. Smith, R. Greig—A Gum Levan, from a saccharum exudate of Eucalyptus Stuartiana.
25. Smith, R. Greig—Levan: a new bacterial gum from sugar. Reprint Jour. Soc. Chem. Ind., Scottish Section.
26. Taylor, Dr. Geo. C.—Dextran: one of the gums of our sugar house.
27. Vignal—The Isolation of Invertase from Bac. mes. vulgatus. Green's Annals of Botany, Vol. VII, p. 120.
28. Ward, Marshall, and J. Reynolds Green—A Sugar Bacterium. Proc. of Royal Soc. of London, Vol. LXV, 1899, pp. 65-85.
29. Wrobleski, A.—Verhalten des Bacillus mesentericus vulgatus bei hohen Temperaturen, Cent. Bakt., 1895.
30. Zopf—Isolation of Invertase from the leuconostoc mesenteroides. Virchow's Archives, Vol. CXXV, p. 156.

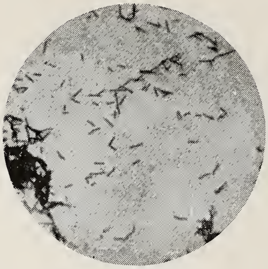
LA.
STATE
UNIV.
LIBRARY



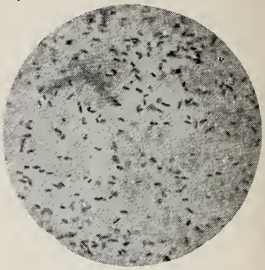
1. Bac. vulgatus A.



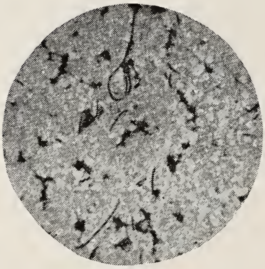
5 Bac. mes. fuscus.



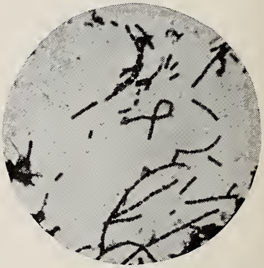
2. Bac. vulgatus B.



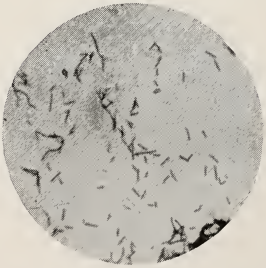
6. Bac. mes. fuscus A.



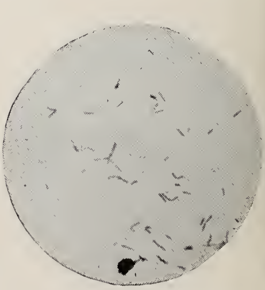
3. Bac. vulgatus C.



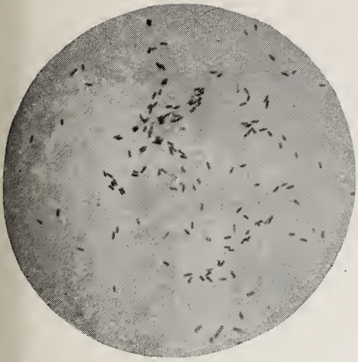
7. Bac. gummosus.



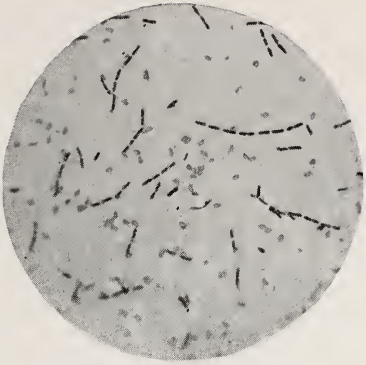
4. Bac. vulgatus D.



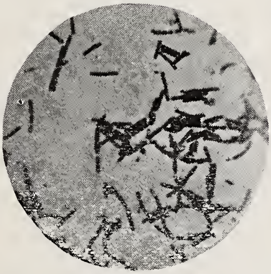
8. Bac. liodermos.



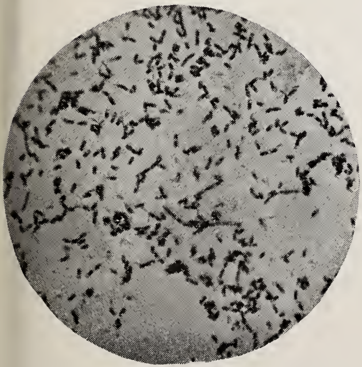
9. Bac. mes. niger.



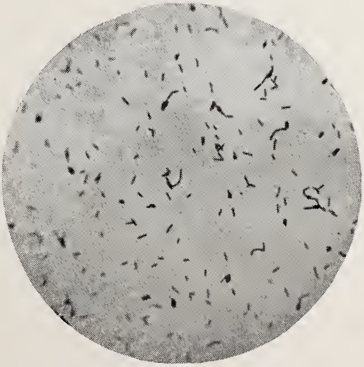
10. Bac. mes. fuscus B.



11. Bac. megatherium.



12. Bac. mes. fucsus granulatus.



13. Bac. mes. ruber.

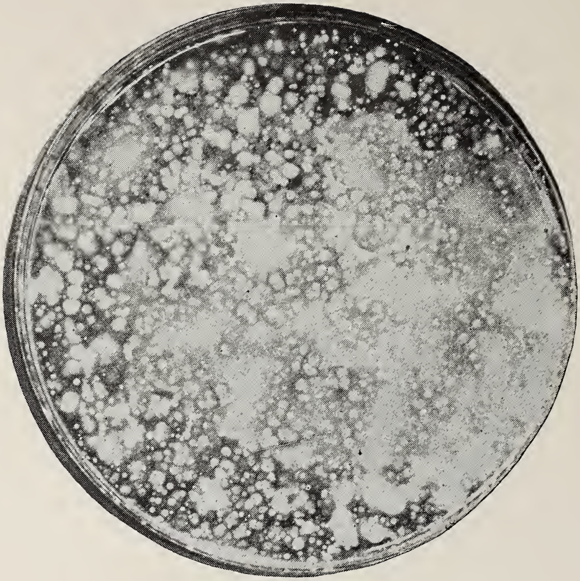


PLATE I.

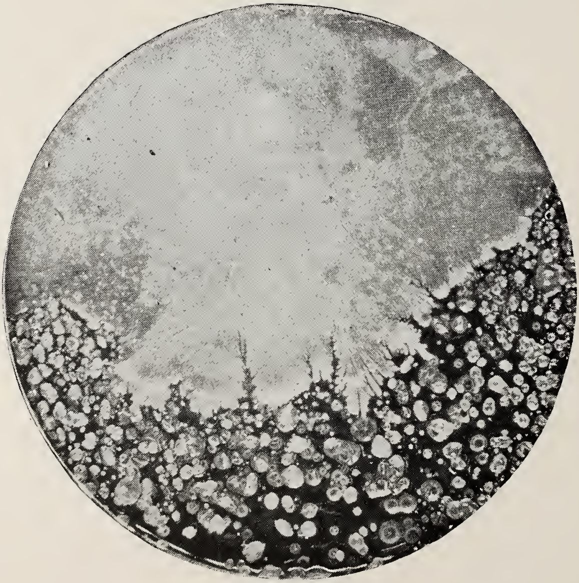


PLATE II.

PLATE I. Bac. vulgatus. (Plain Agar Plate.)
PLATE II. Bac. vulgatus C. (Sucrose Agar Plate.)

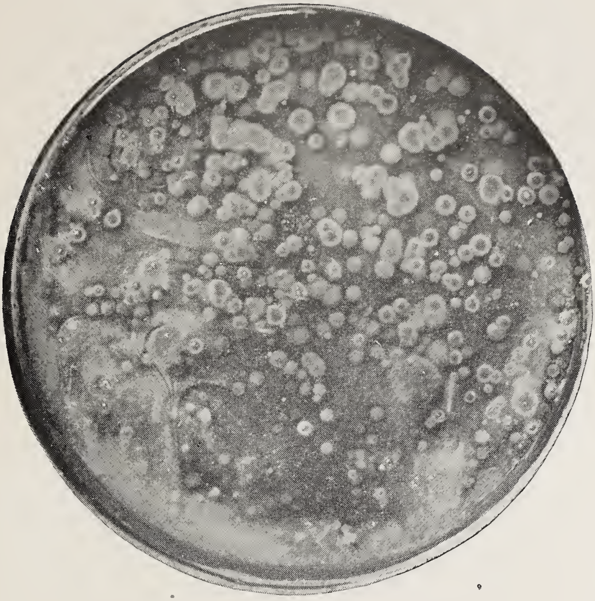


Plate III.

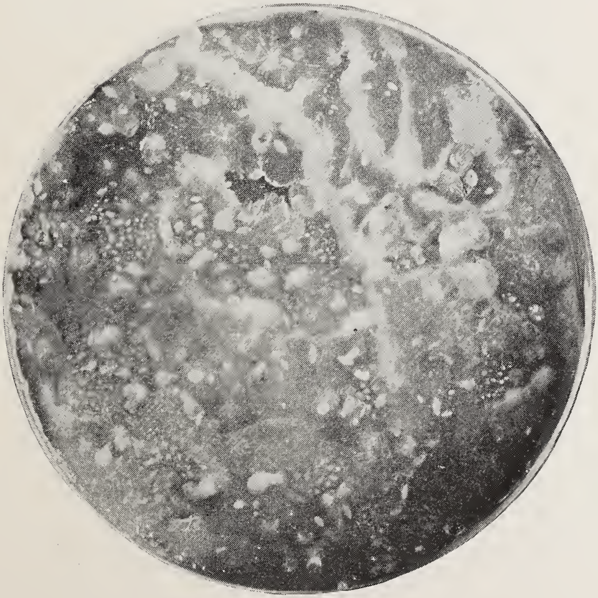


Plate IV.

Plate III. Bac. liodermos. (Plain Agar Plate.)
Plate IV. Bac. vulgatus. (Sucrose Agar Plate.)
Culture showing tendency to liquefy medium.

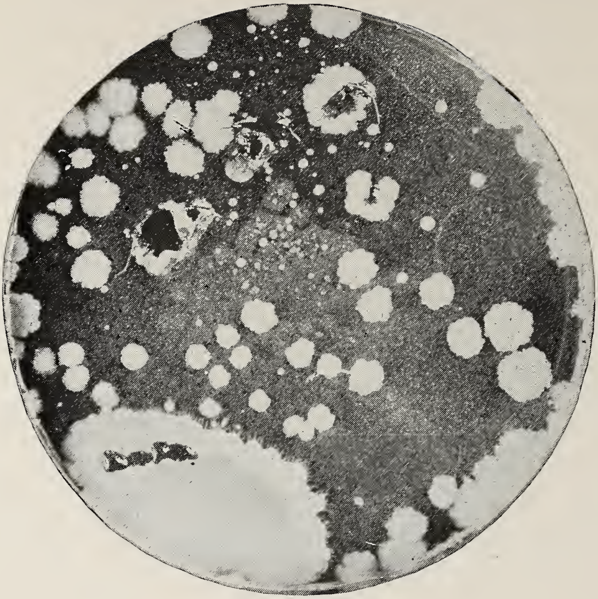


Plate V.

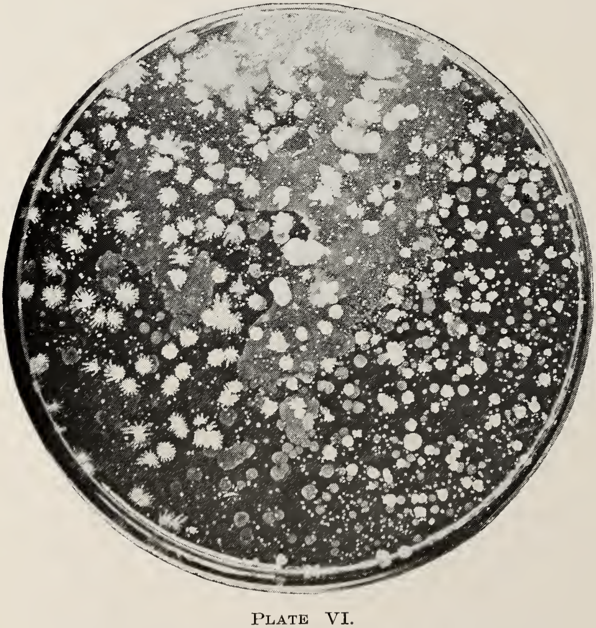


Plate VI.

Plate V. Bac. megatherium. (Plain Agar Plate.)
Plate VI. Bac. mes. muscus. (Sucrose Agar Plate.)

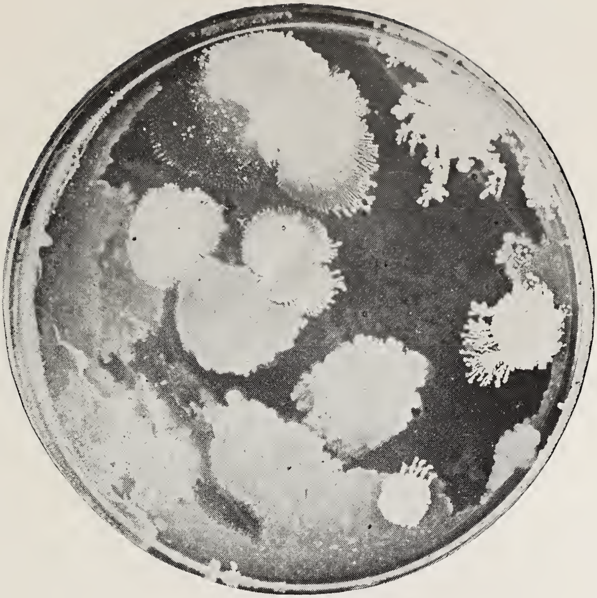


PLATE VII.

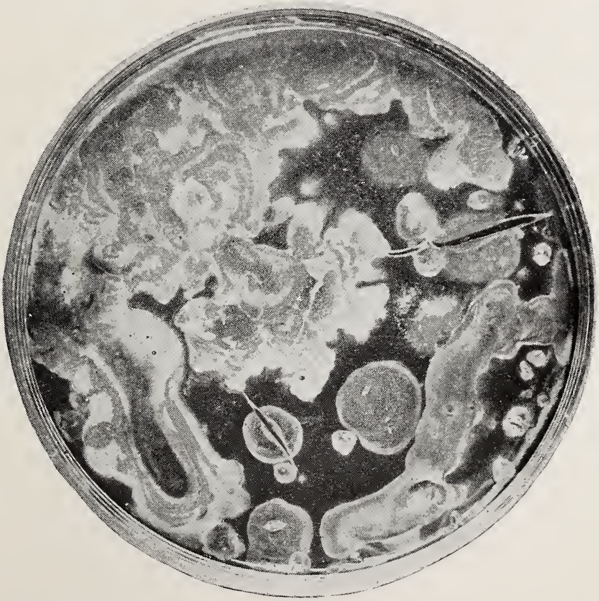


PLATE VIII.

PLATE VII. Bac. mes. fuscus granulatus. (Plain Agar Plate.)
PLATE VIII. Bac. vulgatus B. (Sucrose Agar Plate.

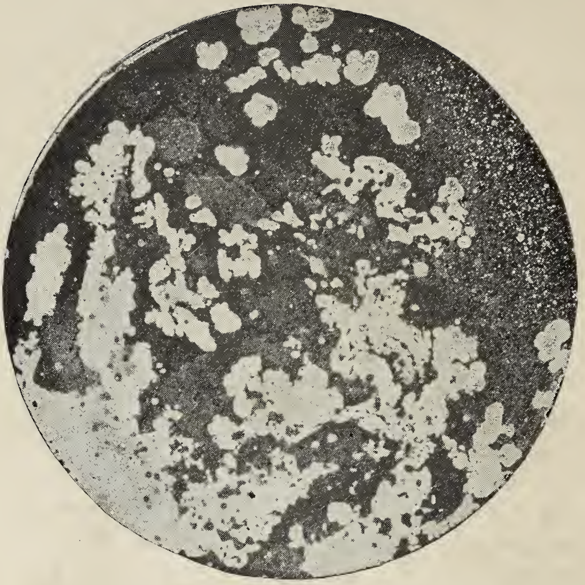


PLATE IX.

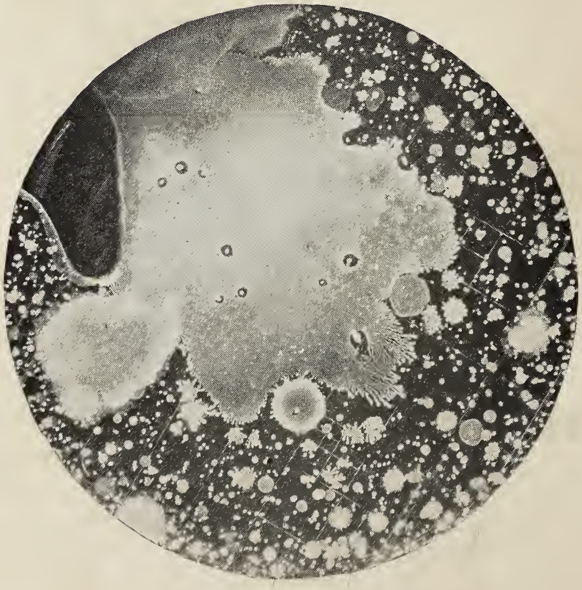


PLATE X.

PLATE X. Bac. mes. fuscus B. (Sucrose Agar Plate.)
P. (95 IX. Bac. gummosus. (Plain Agar Plate.)

83

17

Date Due

LSU Libraries
3 1518 097 539 674